FACTORS ASSOCIATED WITH THE DIFFUSION OF INNOVATIONS IN RICE CULTIVATION IN THE DOMINICAN REPUBLIC

BY

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To my Mother: Maria
To my Wife: Alba
To my Daughters: Agalby and Katty

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The purpose of this dissertation is to explain the relationship of those factors related to the diffusion and adoption of rice technology and to provide a basis upon which the extension and education services of the Secretariat of Agriculture in the Dominican Republic can be improved. The ultimate goal is to provide specific policy suggestions and a framework for designing and implementing services which can be useful to rice producers and to other persons connected with the rice industry.

A discussion of several research traditions in innovation diffusion and the diffusion process is followed by an examination of several models explaining that process. One of these models, the marketing and infrastructural model, is presented as a theoretical approach supporting this research.

A sample containing 478 cases was drawn from a population of 6,723 rice producers who belong to 95 projects under land reform programs. From this sample, 437 farmers were located and interviewed in the field. The investigation used two types of variables: 51 explanatory variables related to factors associated with the innovation diffusion process; and problem variables related to the "technological package" released by the institution that is developing and disseminating rice technology in the country. Two kinds of rice producers were interviewed: those using the seedbed system, whose production system is represented by 50 problem variables; and producers using a direct seed system, whose production system is represented by 37 problem variables. The 50 and the 37 problem variables were then summarized into two separate conceptual problem variables: the adoption score and the degree of knowledge about innovations. Two general and 25 specific hypotheses were established stating relationships among the 51 explanatory variables and the two problem variables.

Two hundred and four correlations were established among the 51 explanatory variables and two problem variables: 102 correlations referring to producers using the seedbed system and 102 correlations referring to producers using the direct seed system. For each category of producers, 51 correlations were stated for the 51 explanatory variables and each of the two problem variables.

From the 204 stated associations, 149 correlations were accepted: 16 cases with level of significance $\alpha \leq .05$ and 133 with $\alpha \leq .01$. A factor analysis applied to the explanatory variables created eleven factors for producers using the seedbed system and ten factors for producers using the direct seed system. A loading of greater than .65 was used as the criterion for including variables in the factors. A multiple regression equation then placed the factors according to their prediction capability. In terms of the adoption functions, innovations' characteristics, inputs' services, and change agent's characteristics were the factors with the greatest explanatory power. Innovations' characteristics, inputs' services and farmer interpersonal communication were the factors that showed better levels of explanation in the knowledge functions.

The research conclusion is that, given the diffusion model supporting this study, the system used in the Dominican Republic to disseminate rice technology lacks some basic elements and should be redesigned to incorporate additional factors. Three recommendations were stated by the writer: a) redefinition of both the system and the role of the institution that is leading in the development and diffusion of rice technology; b) guarantees by the government concerning the sufficient availability of inputs, as well as the quality and fixed prices necessary to the rice production function; and c) that studies to determine benefit/cost relationships be undertaken as a way to establish proper levels of gains for the different sectors involved in the rice industry.

CHAPTER I
INTRODUCTION

This chapter has three parts: definition of the research problem, problem background, and a chapter overview. A brief picture of the rice situation (import, production, real and potential yield) and this research's goals were presented in the first part. The problem background offered the opportunity to know the geographical, socio-economic, and technological factors that in some manner affect the diffusion and adoption of agricultural technology in the Dominican Republic. Finally, an overview summarized the main points of the dissertation.

A. Definition of the Problem

Rice is the most important staple food in the Dominican Republic. Per capita consumption of this cereal was 0.96 quintal[1] in 1975, and the trend between 1962 and 1975 was toward increased consumption both in absolute (total demand) and relative (increase in per capita consumption) terms (see Table I). There are several reasons for this increased demand. First, the Dominican population increased from 1960 to 1970 at the annual rate of 2.9 percent (ONE, 1976:3). Second, migration from rural areas to the cities continues (ONAPLAN, 1976:27-28).[2] Third, the scarcity of substitute foods (plantains, cassava, yam, sweet potato, and potato) grows. These

TABLE 1

HARVESTED AREA, PRODUCTION, YIELD AND APPARENT CONSUMPTION OF WHITE RICE IN THE DOMINICAN REPUBLIC

Year	Area (000 has)	Production (000 qqs)	Yield (qqs/ha)	Imports (000 qqs)	Apparent Consumption* (000 qqs)	Population (000)	Apparent Per Capita Consumption (Quintals)
1962	75.0	1653.6	20.8	0.4	1654.0	3367.0	0.49
1963	78.5	1623.9	20.8	711.7	2324.6	2457.0	0.67
1964	79.5	2035.2	25.6	483.8	2519.0	3587.0	0.70
1965	74.5	2385.0	32.0	1.8	2386.8	3703.0	0.64
1966	76.5	2338.6	32.0	-----	2338.6	3823.0	0.61
1967	74.5	2504.2	33.6	0.4	2504.6	3881.0	0.64
1968	72.5	2553.5	35.2	386.9	2940.4	3941.0	0.75
1969	75.5	2779.3	36.8	-----	2779.3	4001.0	0.69
1970	82.5	3827.1	46.4	-----	3827.1	4061.9	0.94
1971	75.0	3360.0	44.8	-----	3360.0	4181.6	0.80
1972	80.0	3584.0	44.8	195.1	3779.1	4304.9	0.88
1973	96.7	3900.0	40.3	654.5	4554.5	4431.7	1.03
1974	96.5	3684.0	38.1	1549.9	5233.9	4562.3	1.15
1975	86.2	3430.5	39.1	1091.5	4522.0	4696.8	0.96

Source: SEA/IICA, 1976:4

*This column is an aggregation of the production and imports in each year plus the stock received from the past year less the stock left for the next year.

factors have strong and almost permanent effects on the level of demand for rice. Notwithstanding slight increases in productivity and production in recent years, the change in internal production is less than the increase in demand (see Table 1).

The level of production of any crop depends upon two factors: the amount of area under cultivation and yield. In the case of the Dominican Republic, both the volume of rice production (principally by increase in area) and crop yield increased during the period 1962-1975 (see Table 1). Even with such increases in area devoted to rice production and in rice yields, the country between 1972 and 1975 had to import about 3.5 million of quintals of white rice (see Table 1). The value of these imports was US$60 million for the years 1974 and 1975 alone (SEA, 1976a:49).

Since yield is one of the main factors accounting for the production of any crop, and since land is a scarce resource in the Republic, those variables affecting yield must be taken into consideration if production is to be increased. Several studies have determined that yield and technology have a strong, positive relationship (Rogers and Shoemaker, 1971; Rogers, 1976; Stevens, 1977; Schramm and Lerner, 1976). These studies show that such factors as new varieties, fertilizers, pesticides, cultural practices, location of services, among others, are strongly related to the level of production and productivity. Some authors argue that the entire process of national development is related to the diffusion and use of new technology or innovations (Stevens, 1977; Schramm and Lerner, 1976). According to researchers working on rice at the Juma Experimental Station, there is sufficient new technology available at this station to double the actual level of rice production in the Republic. Further, the International Rice Research Institute (IRRI) in the Philippines has completed studies which show that there are countries obtaining an annual yield of 4.71 times the current yield (39.84 quintals per hectare in 1976 of white rice) of Dominican farmers (IRRI, 1975:61-62). In the Dominican Republic, some farmers get yields almost twice the national mean.[3] More significantly, IRRI (1975:61-72) states that production of 605 quintals per hectare per year with more than one harvest, and under the conditions found at the IRRI in Los Baños, Philippines, is already technologically possible. This yield, at Los Baños, represents 15.2 times the mean productivity of the Republic's 1975 rice production.[4]

Rice production in the Dominican Republic, in a sense, presents two contradictory facets. On the one hand, the country needs more and more rice each year, but past and present production is not satisfied by this demand. On the other hand, rice specialists in the country believe that the nation has the necessary technology (new varieties of rice and the "technology package" related to it) to increase productivity and production.

Although the government has engaged in several activities designed to attain self-proficiency in rice, there remain some critical problems. First, the difference between internal production and domestic demand remains large. Hence, the country must import a large amount of rice each year, with a concomitant loss of foreign exchange earnings. Beginning in 1972, the amount of rice imported has increased every year except in 1975 (see Table 1). Second, although rice is a staple food in the Republic that suffers from low yield and production, few research efforts have been made so that they can be used to improve the technological diffusion process. Only one such effort can be identified that specifically treats the diffusion of innovation among rice producers.[5] Third, most of the current programs do not take into consideration such critical factors as the characteristics of innovations, the socio-economic conditions of the farmers, structural conditions, the spatial distribution of the farmers, and all the services needed to harvest this cereal. It is because of the following factors that this dissertation was written: rice is an important item in the Dominican food basket yet current levels of production and productivity are low in relation to internal demand and potential production; local technical knowledge and experience elsewhere suggest that it is possible to increase yields in the Dominican Republic by the diffusion and use of new technology. The objectives of this dissertation are to provide the knowledge necessary to explain the relationships of those factors most related to the diffusion and adoption of new rice technology to improve the services of extension/education in this crop. In that sense, this research is policy-oriented since an ultimate objective is to offer the information needed to design and implement projects which will be useful to rice farmers, the industry, and the Republic.

B. Problem Background

1. Geographical and Socio-economic Characteristics of the Dominican Republic

The Dominican Republic is situated on the eastern two-thirds of Hispaniola Island. It is located at 19.0^{o} N. Latitude and 71.5^{o} W. Longitude. It is the second largest of all Caribbean island countries with a surface area of 48,442 kms. (see Figure 1). There are three main mountain systems: the Cordillera Central, the Cordillera Septentrional and the Cordillera Oriental. The principal rivers, which have a watershed exceeding 2,000 kilometers^2 are: the Yaque del Norte and Yaque del Sur rivers, as well as the Yuna, the Ozama, and Artibonito rivers. There are a number of coastal and interior plains which have the best soils in the country. These include: Cibao Valley, San Juan Valley, Azua and Caribbean coastal plains, Enriquillo Valley, and the plain situated on Barahona Peninsula.

The Republic has a subtropical climate and 44 percent of its land is arable. Due to the trade winds, seasonal temperatures seldom vary. Climate is generally sunny and warm except in the highlands where it is cool. Summer has a mean of 85^{o}F and winter average 75^{o}F. Duarte mountain in the Cordillera Central, with an elevation of 1,375 meters, is the highest mountain peak in all the West Indies.

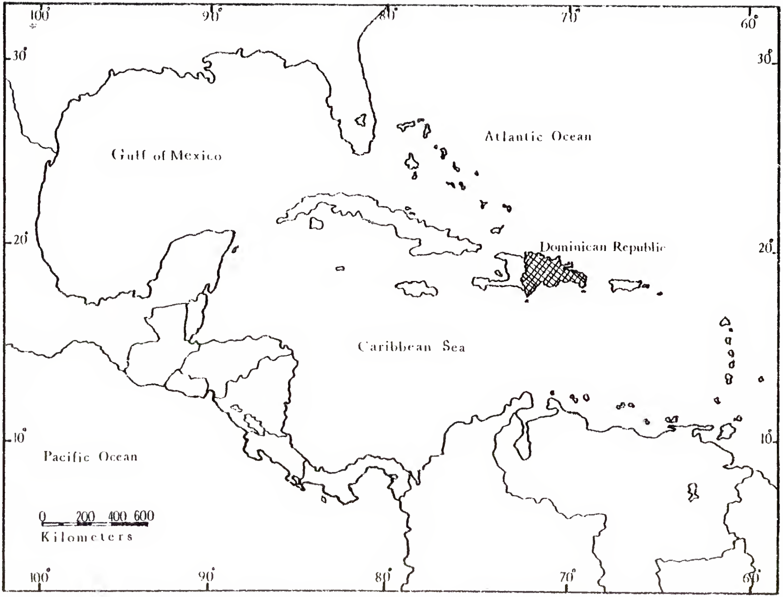


Figure 1. Location Map of the Dominican Republic

The Republic has had a very dynamic population growth. It was increasing to the rate of 3.0 percent yearly in 1976 (ONAPLAN, 1976:455). According to ONAPLAN (1976:456), the urban population increased 10.7 times from 1920 to 1970. Population in Santo Domingo alone had a growth of 22 times in the same period. On the other hand, the rural population only increased 3.2 times in these 50 years. The principal cities of the country with their 1970 population are: Santo Domingo (the capital city), 673,470 inhabitants; Santiago de los Caballeros, 155,000; San Francisco de Macoris, 43,010; Barahona, 37,200; La Romana, 36,720; San Pedro de Macoris, 44,620; and Juan de la Maguana, 32,965 (see Figure 2). The country had 896,665 persons in 1920 and increased to 4,009,458 persons in 1970 (ONE, 1976:3). Population density increased from 18 inhabitants per kilometer^2 in 1920 to 83 persons per kilometer^2 in 1970. Rural-urban internal migration also had a significant change: 17.0 percent of the people lived in rural areas in 1920, but they represented 40.0 percent in 1970 (ONE, 1976:2).

The country's educational conditions present the following characteristics: 75 percent of the population 25 years of age or older had 4 or less years of schooling; 39.0 percent of the same age stratum did not have any kind of schooling degree. On the other hand, only 2.0 percent of the population had 13 or more years of schooling. These statistics present a more critical picture when the population is divided into urban

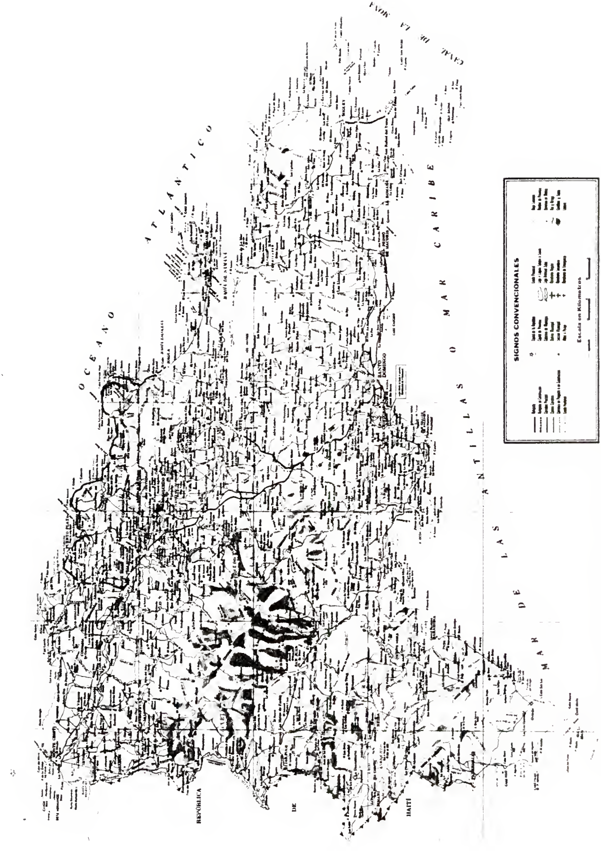


Figure 2. General Map of the Dominican Republic

and rural components. Rural population without any academic level increases to 51.0 percent, while persons with 13 or more years of schooling drops to 0.2 percent. Almost 90 percent of the rural population have less than 4 years of schooling. Urban population is different since 57.0 percent of persons had at least 4 years of schooling (ONAPLAN, 1976:664).

The index of illiteracy for persons 10 years of age or older changed from 34.0 percent in 1960 to 32.0 percent in 1970. Although this small relative reduction was registered, the absolute number of illiterates increased to 19.0 percent during the same period. The 1970 population of 5 years of age or older in elementary school was 1,434,807; the high school population was 135,491, while 35,098 persons were studying at universities (ONE, 1976:165).

Like other developing countries, health conditions in the Dominican Republic are affected by two main factors: nutrition and hygienic facilities. Because of their deficient status, the health characteristics of the Dominican Republic's population are substandard. To illustrate: the general mortality was 11 per 1000 persons in 1970, but according to a new study, the mortality for children up to one year old is presently 128 per 1000 persons in the rural area and 20 pre-school children out of 1000 die each year (Listin Diario, March 16, 1979). The average life expectancy in 1974 for the Republic was 55 years (ONAPLAN, 1976:461).

The population groups with a monthly income not exceeding US$50, which represents 50.0 percent of the total Dominican population, have a caloric intake of 1,324/day and 28 grams of protein/day. On the other hand, the group earning more than US$300/month -- which is 6.0 percent of the total population -- has an intake of 3,150 calories/day and 86 grams of protein/day (SEA, 1976a:102).

In 1974, drinking water for domestic use was available to 82.0 percent of the urban population and to only 26.0 percent of the rural population (ONAPLAN, 1976:463). Housing is affected by the urbanization process and rapid demographic growth in the Republic. The housing deficit as measured in 1969 (last date with available information) is as follows: out of a total of 750,000 units, 250,000 belonged to urban places and 500,000 to rural communities, 40.0 percent of all houses were classified as unhabitable. In other words, the housing deficit represented some 300,000 units in 1969: 100,000 in urban places and 200,000 in the rural (ONAPLAN, 1976:466).

If the country wanted to drastically reduce this deficit, it would need to build 52,500 house units each year over the next 20 years. Despite the fact that both public and private building programs since 1969 are stronger than ever, the number of new houses built in 1975 was only 10,000 units.

In economic terms, the Dominican Republic's labor force represented 31.0 percent (1,241,000 persons) of the total 1970 population. The number of under-employed amounted to 24.0 percent in the same year. In the agricultural sector alone, the sub-employed and under-employed is larger than the national average, at 40.0 percent in 1970 (ONAPLAN, 1976:456-457).

Other economic indicators that help to identify and understand factors affecting development in the Dominican Republic are the following: Gross Domestic Product (GDP) changed from US$462 million to US$776 million between 1950 and 1960 (ONAPLAN, 1976:48), and in 1976, the GDP reached US$2,129 million (ONE, 1976:179). Monthly family income showed the following characteristics for 1973: 50.0 percent of all Dominican families had a mean income of US$36.98. Twenty-six percent had a mean income of US$159.36; and six percent had a mean income of US$761.59 (SEA, 1976:14 and 15).

2. Agricultural Sector

Soils in the Dominican Republic can be classified by land use categories as agricultural soils, soils for grazing purposes, and forest and wildlife soil areas. Out of a total 47,683 Kms.^2 land surface area, 22.4 percent of the land can be farmed, 21.6 percent can be grazed, while 54.4 percent should be used for forest and wildlife purposes (ONAPLAN, 1976: 44-45).

According to the 1971 Dominican Agricultural Census, there were 255,169 farm units in the Republic in 1971, which totalled 2,707,173 has. Small-holder farms, which represent units under 9.9 has. and average 2.6 has. in farm size, represented 86.0 percent of all producers. Small-holders had 21.0 percent of the area under cultivation whereas the largest producers with farms over 1,000 has. and with an average farm size of 2,909 has. represented 0.1 percent of all agricultural land. In the Dominican Republic, there are 216 farmers that alone control 628,264 has. In relation to rice, the data showed that 48.0 percent of rice producers belong to public projects and they have farms smaller than 4 has. (ONE, 1976:29; SEA, 1976a).

Further, the Agricultural Census indicates that of the farm units in 1971, 53.0 percent were owner-operated by producers, 7.0 percent were rented or leased, 4.0 percent functioned under the government's agrarian reform program, 19.0 percent were used by non-titled holders, and 0.4 percent were under other forms of ownership; some 17.0 percent of the total number of farms were held by more than one type of ownership (ONE, 1976:30-31).

The hydraulic resources of the Republic include 108 separate watersheds but there are five main river systems that are grouped for management purposes into several hydrological zones. To improve the use of these resources, the government has built many dams, irrigation systems and drainage channels in different places. Actually, the land under irrigation approaches 125,000 has., but the country has a total potential area of irrigable land of some 343,725 has. Today, almost half of the irrigated land is being used for rice production (ONAPLAN, 1976:45 and 192).

Public expenditures in dams and irrigations channel construction totalled about US$600 million from 1966 to 1976 (Breton, 1977:4) Other large-scale public sector investments have been committed to extend the network of farm to market roads and thus make accessible isolated small agricultural communities (Breton, 1977:3). Additional services being provided to farmers include infrastructures such as marketing facilities, storage and transportation; inputs including seed, fertilizer, and pesticides; as well as credit.

The government-operated agricultural bank was the source of 58.0 percent of all loans to agricultural producers in 1975 (ONAPLAN, 1976:352 and 357). In 1969, the credit offered by the public sector was US$28.0 million (69.5 percent) while the private sector lent US$12.3 million (7.4 percent of all given credits). In real terms, the public sector lent US$78.0 million while the private sector lent US$56.6 million.

The market system of the Republic is strongly influenced by the private sector. This sector buys most on-farm products and receives very high profits in some product areas. In the case of rice, which is one of the products with better conditions, the price received by the producer represented 67.6 percent of the consumer price in 1976 (SEA, 1976:57).

Two government agencies are buying or helping to sell part of the agricultural produce. The Dominican Export Promoting Center (CEDOPEX) and the Price Stabilization Institute (INESPRE) are the public service agencies which provide this function. INESPRE, which is responsible for at least rice, beans, sorghum, onion, vegetable oil, sugar, corn, garlic, and potato works at the wholesale level, but is faced with severe limitations to fulfill its role. Storage capacity, transportation facilities, and working capital are usually in shorter supply than the amount needed. For these reasons, the private entrepreneurs can easily trade with producers at a good price and under the best conditions (favorable to the buyers). Really, only rice has received adequate attention from INESPRE, although this agency has difficulties in paying the producers (ACRD, 1976:1971-3; SEA/IICA, 1976).

Seed, fertilizer, pesticide and other inputs are reaching the farmers from the Secretariat of Agriculture (SEA) and several private firms. This governmental agency is strongest in rice, beans, corn, potatoes, and other seeds. SEA also has a small program to sell fertilizers, pesticides and other inputs which are expensive and sometimes are not available at the local level. The private sector is also trading in these products but at higher prices and problems with quality and location exist.

Data show that the importance of the agricultural sector in some aspects of the economy is declining over time. The contribution of agriculture to the Gross Domestic Product (GDP) has been declining since 1960. This sector contributed 31.8 percent in 1960; 25.3 percent in 1969; and 18.0 percent in 1974 (ONAPLAN, 1976:35). This was the only sector that showed this kind of tendency.

In spite of the fact that agriculture has been declining, it still plays a very important role in the whole economy. More than 60.0 percent of the population lives and in some way depends on economic activities, most of which are related to the agricultural sector (ONE, 1976:3). In 1975, agricultural products represented 76.3 percent of total exports (ACRD, 1976:102). In a very real way, agriculture is providing the new material base for manufacturing.

The major agricultural products for domestic consumption are: rice, peanuts, tomatoes, beans, bananas, manioc and plantains. By-products of cattle, hogs, and chicken are other important nutritional elements. The principal agricultural exports are: sugar cane, tobacco, coffee, cocoa and some types of fruits and vegetables (ACRD, 1976:95).

3. Technological Base: Research and Extension/Education

There are several institutions in the Dominican Republic working in areas of research and development in the diffusion of scientific and technological innovations (RD/D). Fifty-eight percent of all such institutions belong to centers of higher or specialized education, while government agencies represent 25.0 percent and the private sector firms account for 13.5 (APEC, 1973:1). Most of these institutions are working under severe restrictions because of the scarcity of economic and human resources. The total cost of research and development in technological transfers is financed mostly by the public sector: the government spends 90.0 percent and the private sector offers 9.1 percent (APEC, 1973:23).

Of all the 135 research and development related institutions working in the Dominican Republic in 1972, 28 (20.8 percent) of their total were from the agricultural sector; and of those 28 agencies, fifteen (54.0 percent) belonged to the government bureaucracy; five (18.0 percent) to private universities; five (18.0 percent) to government-run universities; and two (7.0 percent) to private firms (UNICYT, 1975:7).

Sixty percent of these 28 institutions became operational after 1967, 30.0 percent after 1961, and 10.0 percent after 1941. Such figures show that most of the research and development infrastructure in the country is relatively young (UNICYT, 1975:7).

There were 1,764 skilled workers belonging to these institutions in 1972, of which 1,420 (81.0 percent) were classified as scientists and 344 (19.0 percent) were classified as technicians. Sixty-seven percent of all such workers belonged to government agencies while 34.0 percent belonged to the private sector (APEC, 1973:35).

Of the 169 persons working in research-related activities in 1976, 26 (15 percent) had graduate degrees, 14 (8.0 percent) had completed some form of graduate studies, 92 (54.0 percent) had received a degree, and 37 (22.0 percent) had no degree or had finished all course work but thesis (SEA/IICA, 1977:27).

A perusal of statistics concerning human resources shows that the natural sciences have the highest priority of investment (26.6 percent); both agriculture and the social sciences have second priority (20.8 percent each); while the humanities and law have 9.6 percent each (APEC, 1973:5). Several fields in engineering register a priority of 8.9 percent, as do medicine and related fields.

If the geographical dimension is taken into account, it can be observed that there is a heavy concentration of institutions as well as human and economic resources in Santo Domingo (APEC, 1973:12). Santo Domingo accounts for 73.1 percent of all institutions working in research and development, 72.9 percent of all variable investment, and 75.7 percent of all technicians and scientific personnel. Santiago de los Caballeros ranks second with 19.2 percent of all the institutions, 10.8 percent of the economic infrastructure, and 17.6 percent of the Republic's human resources. Cities and towns with smaller proportions of investments related to the agricultural fields include La Romana, San Cristobal, and Dajabon. According to APEC, all institutional investments in research and development related to agricultural technological innovation in 1972 amounted to US$46.6 million (APEC, 1973:20). Sixty-six percent of this investment was for variable costs and 34.0 percent was for fixed costs. Considering the fact that 46.6 million represents only 0.1 percent of the GDP for that year, it can be said that the Dominican Republic is one country investing little to improve its agricultural situation. There are countries that spend about 3.0 percent of their GDP in these activities. The U.S., for example, invested 3.0 percent in 1966 and today it is investing only slightly less. Other Caribbean and Latin American countries, with the exception of Jamaica (0.1 percent in 1971), are investing more resources for research and development related to innovations in agricultural technology.

Trinidad used 0.2 percent of its GDP for these activities in 1970, Paraguay used 0.2 percent for the same purpose in 1971, and Argentina used 0.3 percent.

Six different categories, in addition to the administrative tasks of research and development efforts, can be identified in the Republic. These include, with their associated costs: basic research (0.5 percent), applied research (3.8 percent), technological development (0.8 percent), diffusion (2.5 percent), related activities (11.8 percent), and educational activities (22.5 percent) (APEC, 1973:43). These data indicate that such key areas as basic and applied research, along with technological development and diffusion, are only receiving 7.6 percent of total funding.

The last item to scrutinize is the connection between research and development that is related to agricultural technological diffusion and the socio-economic goals of the country at large. Using as indices of research and development the above six relative funding categories, as well as indices of socio-economic goals,the activities defined in government plans, agricultural programs, and projects, the following conclusions can be reached (APEC, 1973:117). Agriculture and livestock received 2.3 times more attention (economic, human and institutional resources) in research, development and diffusion than did the socio-economic goals of the nation; education received 1.4 times more attention than did socio-economic goals. Other activities, such as support for administrative work related to research and development, received 1.2 times more attention than did socio-economic goals. On the other hand, mining and related fields received 0.1 times more attention, electricity and construction sectors received 0.2 times, and industrial activities received 0.3 times the attention given to socio-economic goals. Finally, education received 0.4 times the attention in research, development and diffusion than was directed towards socio-economic goals.

The APEC study recommended that six main topics must be taken into account in future research and development work: (1) development of an institutional infrastructure; (2) formulation of a national policy; (3) improvement in research and technological development activities; (4) improvement in research development at the university level; (5) more support for research and development activities in general; and (6) study of the importing of non-indigenous technology (APEC, 1973:133,138,140,143,145, and 146).

The Secretariat of Agriculture between 1973 and 1977 conducted 574 trials or tests in the following areas: 207 (36.0 percent) for genetic improvement; 126 (22.0 percent) for cultural practices; 87 (15.0 percent) about fertilization; 80 (14.0 percent) concerning plagues and disease control; 14 (2.0 percent) related to irrigation; and 60 (10.0 percent) for multiple purposes (SEA/IICA, 1977:44). The results of these trials are spread through 82 local offices of the Secretariat of Agriculture located throughout the country (SEA/IICA, 1977:5). Some 420 extension agents are spreading this new technology by giving advice to farmers raising and planting, principally, such crops as rice, beans, corn, plantains, and manioc. Several communication techniques such as demonstration plots, field trips, workshops, short courses, videocassettes, and printed material are used by the extension agents for diffusion innovation information.

4. Rice Cultivation

The rice plant will flourish under such widely differing climatic conditions that it is difficult to define the most suitable place for its cultivation. Although higher yields are obtained in countries with sub-tropical or warm temperature climates, rice can grow over a wide range of conditions extending from 45° N. Latitude to 40° S. Latitude. The most extensively cultivated areas are found in Central America, the southern portion of the U.S., the West Indies, most of South America, parts of Africa, Australia, India, most of China, Japan, the Malay Archipielago and the Pacific Islands. Though all of these countries are situated within latitudinal limits described above, the highest yields are recorded between 30° and 45° Latitude (Grist, 1970:10).

Most researchers agree that rice (Oryza sativa 1.) originated in India and that the diffusion of this cereal was both fast and widespread (SEA, 1976c:1). Rice spread from India to China, from China to Korea, then to Japan and the Philippines, it also spread from India to Indonesia and Sri Lanka (SEA, 1976c:1).

According to Grist, specimens of rice have been discovered in China dating from the third millennium B.C., and the

Chinese term for rice appears in inscriptions dating from the second millennium B.C. He further states, "paddy cultivation probably dates back to the earliest age of man, and long before the era of which we have historical evidence, it was probably the staple food and the first cultivated crop in Asia" (Grist, 1970:5).

The major spread of this crop started with the Arabian trips after the Fourth Century, B.C. and before the Tenth Century after the Christian era (SEA, 1976c:1). During this historical period, rice reached Egypt, the West Coast in Africa, Morocco and Spain. Rice was brought to America by the Portuguese and Dutch. It arrived in this continent through North Carolina and Brazil in the last part of the Seventeenth Century. The most dramatic spread of this cereal began in the Twentieth Century and it took place after the development of improved, high yield varieties.

It is uncertain exactly when rice was introduced into the Dominican Republic. There are two hypotheses concerning its introduction and diffusion (SEA, 1976a:1). One states that rice was established in wild form when the first European voyages came to Hispaniola in 1492. According to this view, rice was first located in the lowland where rainfall was heavy. The other hypothesis states that rice was introduced into Hispaniola as a by-product of discovery and colonization. In this case, rice was introduced as part of the large-scale diffusion effort that was a result of the many voyages undertaken during that period of time.

In any event, the fact is that rice has been cultivated in the Republic for several hundred years. First it was planted when rainfall was heavy. Following that initial period, it was then planted in swamps. In both cases, small areas were harvested, principally, for local food consumption. A hole in the ground was made with a stick, from six to eight seeds were dropped into it, after which the hole was covered with soil. In this system, the planting process was only possible during periods of rainfall. Harvest was a plant-by-plant process. These harvested plants then were tied together and dried in the sun, then the rice seeds were shelled by hitting the plants with a wooden stick. The rice rind was removed by striking the seeds with a large wooden mortar.

Rice production became a commercial activity in the Dominican Republic after 1917. At that time, it became an important industry in the northwestern Cibao Valley and in the San Juan de la Maguana inter-montane valley situated in the west center part of the Republic. The construction of irrigation channels started in 1925 and this event enabled rice production to assume a position of commercial importance (SEA, 1975:3).

When rice became a profitable activity, many new varieties, such as "Fortuna" and "Buffalo" were introduced, principally from the U.S.A. Before the crop was handled scientifically in 1962, at least two important events took place. Both were in the region of Valverde, Mao. In the first case, a variety was obtained from the imported "Buffalo" variety, called "Canilla."[6] The other discovery was made in 1943 when a farmer selected some seeds from natural breeding between the varieties "Fortuna" and "Canilla," which became known by the name of "Tono Brea"[7] (SEA, 1975:2).

In 1953, a first unsuccessful attempt was made in the Dominican Republic to establish rice research and diffusion center at El Pozo, Nagua. However, it was not until nine years later that such a center was effectively placed into operation at Juma, Bonao. The ultimate goal of this rice experimentation is to increase productivity and production of rice throughout the country. Juma Experimental Station attempts to achieve this objective by carrying out agronomic research on high yield varieties as well as effectively diffusing such varieties.

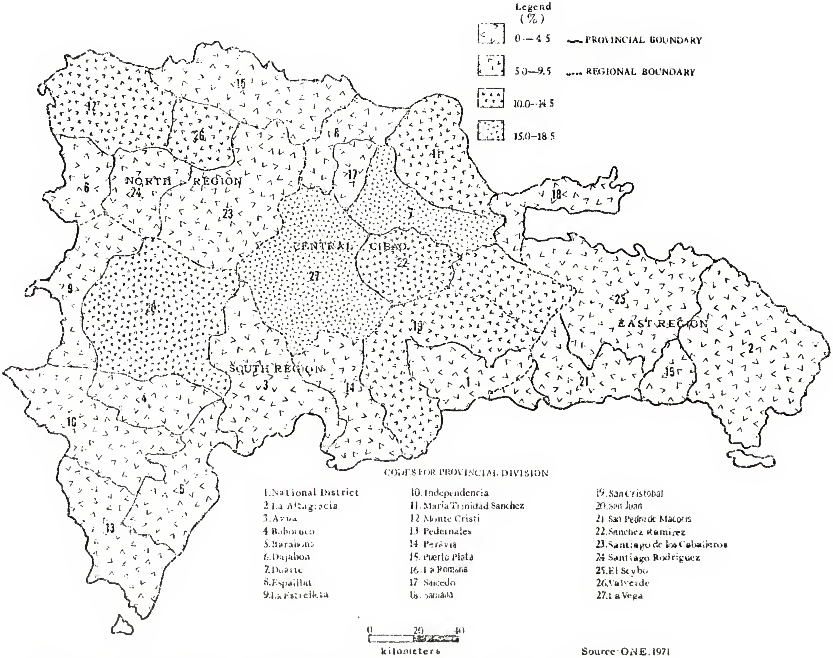
Since the station's inception, a Taiwanese technical mission has been working with Dominican technicians in research and diffusion with strong support from the rice growers. An important adjunct of this program is the fact that many Dominican technicians have received on-the-soil training at Juma.

Before the establishment of the Juma Experimental Station (EEAJ), the agricultural credit bank (Banco Agricola de la RD) improved the importation of several varieties (Rexoro, Blue Bonnet, Century Patna, Blue Rose, etc.). Most of these varieties were imported from the U.S. Some varieties gave good yield the first years but then, they changed the original characteristics and degenerated (SEA, 1975:3).

The area under rice production in the Republic changed little between 1962 and 1975, 8.4 percent, from 79,500 has. to 86,188 has. Table 1 indicates, furthermore, that the smallest area under rice cultivation was planted in 1968 (72,544 has.) while the largest was planted in 1973 (96,669 has.). In 1976, 52.0 percent of the area under production (69,357 has.) was owned by private producers; 48.0 percent was owned by individuals under land reform programs (SEA, 1976a).

The geographical location of these ten principal rice producing regions (accounting for 93.5 percent of the national producing area) is shown in Figure 3. The four most important provinces are Duarte (18.2 percent), La Vega (16.1 percent), Sanchez Ramirez (12.7 percent), and San Juan de la Maguana (12.1 percent). If the provinces producing rice are grouped by "natural boundaries," four regions can be delineated: North, Central Cibao, South, and East. The Central Cibao is the largest producing region with 55.3 percent (38,355 has.) while the East region is the smallest one with 6.8 percent (4,687 has.) of the national area.

Except for the years 1965, 1966, 1969, and 1971, the internal demand for rice increased almost every year between 1962 and 1975. Domestic consumption grew 2.7 times in this period, from 1,654,000 qqs.[8] to 4,522,000 qqs. (see Table 1). The peak demand year was 1974 with 5,233,900 qqs., while the smallest demand year was 1962. Per capita consumption also changed: it increased 2.0 times in this period, from 0.49



Source: ONE, 1971

Figure 3. Percentage of Area under Rice Cultivation by Provinces

qqs. to 0.96 qqs. (see Table 1). The largest per capita consumption figure (1.15 qqs.) was registered in 1974, while the year with smallest per capita consumption was 1962 (0.49 qqs.).

On the supply side of the equation, there are two sources of rice: domestic production and foreign imports.[9] Domestic production grew 2.1 times between 1962 and 1975, from 1,653,600 qqs. to 3,430,500 qqs. (see Table 1). The year registering highest production was 1973 (3,000,000 qqs.), while the lowest production figure was in 1963 (1,623,900 qqs.). Data about imports showed that the country did not import for four years, importations were very small for three years, there were seven years with annual imports exceeding 386,900 qqs., and the largest import was in 1974 with 1,549,900 qqs. (see Table 1).

Production function for rice, like any production process, includes input factors and final output. Then, final product depends upon the amount, quality and opportunity of the inputs. The classical division of land, labor and capital also applies to rice cultivation. In this instance, capital means physical inputs (e.g., seed, fertilizer, pesticides, and water), and services (technological services, credit, and marketing facilities). The profitability is another important element in this production function. All of the above factors are analyzed briefly in order to provide a conceptual economic baseline for the diffusion research reported in the following chapters.

Almost all knowledgeable persons in the Dominican agricultural sector agree that rice farming is a profitable business in the Republic. For instance, profitability of this activity is high if the scale of production and the needed inputs are available. Although according to the Secretariat of Agriculture, the potential profit from rice sales is high with the current technology, if this level of technology is increased, the net return will increase at higher levels (SEA, 1976b:25-27).

Seeds are offered to rice producers from five different sources, but quality and availability of this input is only partially satisfactory. The two best quality sources are the Secretariat of Agriculture and the Dominican firm, Productora de Semilla, C. por A. In 1977, the Secretariat sold 18 percent of all the needed seed while Productora sold 10 percent. There were a number of farmers who kept part of their harvested rice until the next season and then sold it as seed to other producers, supplying 25 percent of the total demand. Merchants who bought rice and held a portion to be sold later as seed, satisfied 17 percent of the demand. Farmers who used part of their rice to seed their own farm and after that sold the surplus to other producers, met 30 percent of the total demand for seed.

Fertilizer is widely used by rice producers in the country as 95.3 percent of the rice area is fertilized (SEA, 1975:30).[10] Despite the relatively extensive use of fertilizer, several factors restrict its more efficient use.

These factors include: (1) the formula used oftentimes does not coincide with actual soil conditions since farmers are not able to characterize the soils on their farms; (2) the amount applied is usually inadequate for the above reason as well as the fact that each rice variety has different dose requirements; (3) application is generally out of sequence, usually it is applied too late; (4) the method of application is too slow and the distribution of the product is uneven; (5) fertilizer is under-utilized due to the unknown quality of the land; (6) fertilizer quality seldom satisfied specifications found on the label (SEA, 1976a:41-42).

Most pesticides applied in rice cultivation are herbicides, insecticides and fungicides. Here, too, there are several factors limiting the effects of pesticides: type of product applied; preparation and handling of the land; the amount applied; the date applied; and the method of application (SEA, 1976a:45).

Marketing of unprocessed rice usually follows one of two channels: rice may be sold either through a local intermediary who sells to buyers located outside the producing area, or it may be sold through local factories. In both cases, the marketing system discriminates against the small producers (SEA, 1976a). Although prices are regulated by law, the implementation of these laws is not effective in most cases. Poor regulation is due to a number of factors: an important proportion of the credit is non-institutional credit which is related to the reciprocal sale of the product back to the lender, negotiating strength of the producer is very small in contrast to the seller, information about price, measurement, supply and demand of rice seldom reaches the producer, and finally, the seller can misrepresent quality and weight of rice as well as details concerning the loan.

Agricultural settlements on public lands are beginnning to develop an organizational framework that may alter the present situation of control and dependence. These collective farms have established credit committees, which not only determine the best buyer, but also negotiate the sale price to the advantage of the producer. This is possible because no producer can sell the rice individually; all must sell collectively. Since credit is obtained from the public bank, the producers are no longer placed in the position of having to negotiate the sale of their harvests with the lender. Although individuals farming on public land also have a committee to deal with rice sales, these producers can sell their product individually and as a result, it is sometimes difficult that they receive the same sale conditions (SEA, 1976b).

The drying, processing, and storage of rice can be characterized as follows. There are 331 rice factories which have 33 percent more than the needed capacity.[11] Although there is a surplus in rice processing capacity at the national level, the distribution of such facilities is not satisfactory. In the San Juan de la Maguana region, for example, where production has remained more or less the same, the available facilities are not enough to meet demand (SEA/IICA, 1976:63).

Storage is available both in public (INESPRE) and private warehouses. According to the Secretariat of Agriculture, there is a 4,747,000 qqs. storage capacity in the Republic. Yet, despite the fact that such a capacity may be enough, due to quasi-stationary national production, sometimes, shortage can occur (SEA, 1976a).

Credit is a paramount factor in rice production since the use of new technology depends on capital availability. In the Dominican Republic, where 90.0 percent of the farmers are rice producers with less than 6.2 has., loans are needed to finance production (SEA, 1976:6). Loans come from two main sources: the public bank (institutional credit) and rice factories (non-institutional credit). In 1974, public bank gave 70.3 percent of the total credit used by rice producers, while factories lent 29.3 percent. Since the production cost for rice was about US$672 per hectare, and the credit obtained only paid for about 55.0 percent of the total production cost, it was sometimes necessary for producers to borrow from both institutional and non-institutional sources (SEA, 1976a).

In 1975, US$34.7 million of credit was given by the public bank. This represents 62.0 percent of all loans given in the agricultural sector by institutional sources (ACRD, 1976:102). The farmers used such institutional credit during that year in the following manner: 44.4 percent to pay labor; 17.5 percent to buy fertilizer; 6.4 percent to take care of household problems; 17.5 to service machinery; 6.5

percent to buy seeds; and 7.7 percent for other uses (SEA, 1976b).

Although 98.0 percent of all rice cultivated in the Republic is irrigated (SEA, 1978a:1), only 46.7 percent of all public irrigated lands are used for rice. Twenty-three and three tenths percent of such lands (17,500 has.), however, have been classified as dry areas because the irrigation channels are inefficient or because the available water is insufficient for all producers who depend on the system (ONAPLAN, 1976:192).

The rice experimentation station at Juma in Bonao is the premier rice research facility in the Dominican Republic. Established in 1962 under bi-national agreement between the Dominican and Taiwanese governments, this station has 44 has. of land, 15.6 has. devoted for crop experimentation and 28.4 has. to seed reproduction. The research and extension staff consists of six university-trained professional agronomists, nine sub-professionals and four foreign advisers. In 1976, there were 61 auxillary workers attached to this agency and the station's budget was US$160,699.00 (SEA/IICA, 1976:39).

The results emanating from the station's research projects form the foundation for improving rice production and yield. These projects focus on collecting, purification and selecting local varieties; introducing and adopting varieties and genetic material from other countries; and developing new varieties by artificial breeding.

Results from the earlier projects in 1966 focused on the varieties "Toño Brea 408" and "Toño Brea 339" (SEA, 1971: 12-13). Since then, other varieties of rice have been developed and released; among them are included Juma-1, Juma-32, Juma-57, Juma-58, and Juma-60 (Tanioka), all of which have given excellent yields and are diverse enough to be planted in different regions of the country. Between 1973 and 1977, the station carried out 78 trials (SEA/IICA, 1976: 44): 20 trials concerned variety improvements; 19 dealt with cultural practices; 23 with fertilization; 9 with pest control; 6 with irrigation; and 1 with other topics.

The purposes of extension education with rice are to increase production and productivity of this crop. These purposes are pursued by diffusing new varieties and improved cultural practices. Extension services are provided for rice cultivation on government projects, as well as to private entrepreneurs. Short courses, workshops, field trips, demonstrations, use of plots and dissemination of printed material are several of the more common methods used.

During 1976-1977, six courses, each of ten weeks duration, were given to 75 technicians. An additional 155 rice producers received training in several five or six day courses. Five demonstration plot sites were set up for farmers working on public lands in several localities (Mision Tecnica Agricola China, 1978:22-23).

There are an estimated eighty extension agents working on rice. The efforts of these change agents, in addition to the effort of other technicians working at the Juma Experimental Station, have made it possible to increase the area planted in new rice varieities as follows: 16.0 percent of the total rice was planted in new varieties in 1975; 23.0 percent in 1976; 26.0 percent in 1977; and an estimated 30.0 percent in 1978 (Mision Tecnica Agricola China, 1978:23).

C. Overview of Following Chapters

The second chapter presented a theoretical framework about diffusion of innovation related to agricultural technology. It begins with a brief exposition about diffusion research traditions, then, concepts and definitions in the diffusion process are discussed, finally, several models explaining the diffusion process are analyzed. One of these models was offered as a foundation for the concepts underlying this dissertation.

Chapter III covers the research purpose, scope, variables and hypotheses. Two kinds of variables are explained there: explanatory variables (which means factors associated with innovation diffusion process) and problem variables (which means the "technological package" released by Juma Experimental Station which is developing and spreading rice technology in the country). Hypotheses about relationships between explanatory and problem variables are stated in this chapter, they are grouped into two categories: general and specific hypotheses.

Definitions of variables, discussion of the questionnaire used to record information in the field study and procedures used to obtain the sample population are presented in Chapter IV. After the explanation of the field study, correlation, factor analysis, and multiple regression equations are discussed as statistical techniques in the section about data processing and reduction. The last point of Chapter IV explains the study's limitations.

Chapter V analyzes the general and specific hypotheses, using factor loading and levels of confidence as critical points to accept or reject the hypotheses. Factor analysis was used to group the explanatory variables into components which represented the concepts underlying each variable in the factor; in addition, this technique made sure that a group of variables is independent with respect to the others. Finally, multiple regression equations ranked the factors according to their predictive power.

Conclusions and recommendations are presented in Chapter VI. They summarize both the findings of this research and knowledge and experiences acquired by the author of this dissertation through other means during his work at the Secretariat of Agriculture in the Dominican Republic.

Notes

[1] Quintal = 100 pounds

[2] While the increase in rural population is 1.3 percent per year, the growth of the population in Santo Domingo is 5.6 percent per year.

[3] In earlier research, the author of this work found that Mr. Jose Perin, a rice producer in Rincon, La Vega, Dominican Republic, gets yields that are twice the national average.

[4] The mean yield in the Dominican Republic is for a single harvest, whereas the yields reported by the IRRI represent several harvests in a year. In addition, it is not clear if the IRRI is talking about white or gross rice.

[5] This study was made by I. Jose Cepeda in the locality of Juma Caracol, Dominican Republic. It was a thesis for the M.S. degree at the Universidad Nacional de Colombia, Bogota. The research was carried out in 1976 and the main goal was to determine and analyze the factors related to the adoption of agricultural technology among rice producers in a small community. The author states several useful conclusions which can be used to improve extension services in the locality.

[6] This variety was developed by the Bogaert family which was a pioneer in the establishment of this crop under irrigation facilities in the Valverde region.

[7] This variety was selected by Antonio Brea when a natural breeding took place in the "ISA" farm in the Valverde region.

[8] qqs. = quintals of milled rice.

[9] In this case, the supply is the same as the demand because the demand has been defined by the aggregation of both internal production plus the amount imported.

[10] The rice crop used 17.5 percent (36,432 tons) of all the fertilizers applied in the country in 1974 (SEA, 1976a: 40).

[11] They have the capacity to process six million of qqs. of milled rice. That is only working eight hours per day, 250 days per year.

CHAPTER II
THEORETICAL FRAMEWORK IN INNOVATION DIFFUSION

Chapter II has three main points: diffusion research traditions, concepts and definitions in the diffusion process, and models that explain this process. Eight fields were briefly analyzed in the first point which were anthropology, early sociology, rural sociology, education, medical sociology, communication, marketing, and geographic traditions. The concepts of innovation, communication channels, unit of adoption, time, and space were presented in the second part of this chapter. Finally, hypodermic needle, one-step flow, multi-step flow, traditional, and marketing and infrastructure models are presented to give a picture of the prevalent approaches dealing with the innovation diffusion process over the last decades. The marketing and infrastructure model was discussed as the conceptual background of this dissertation.

A. Diffusion Research Traditions

A historical perspective on diffusion studies shows that researchers have been studying the process for several decades in several different disciplines. Although Rogers and Shoemaker (1971) and Katz, Levin and Hamilton (1963) say there are seven main traditions in diffusion research (anthropological, early sociological, rural sociological, educational, medical sociological, communication, and marketing) the author of this study believes with others (Hagerstrand, 1967; Brown and Lentnek, 1973; Brown, 1975; Blaut, 1977) that an eighth tradition, the geographic, must be added. Almost all the traditions agree that innovation diffusion is a major mechanism of social and technical change. A brief discussion of the eight traditions is presented in the following pages.

The anthropological tradition is the oldest and it has had strong influence over the sociological, especially after the 1920's. This tradition shifted its study focus with the passage of time. In the early days, it examined whether diffusion or parallel invention was the more important to social change. The introduction of modern Western ideas to primitive societies was the dominant theme. Problems of acculturation were studied in detail. In recent years, attention has been given to the study of cross-cultural programs of technical assistance and their relationships with structural, socio-economic and ecological variables. The scale of study has always been at a microcosmic level: small communities and peasant villages (Rogers and Shoemaker, 1971; Blaut, 1977:344).

The second tradition, early sociological, is attributed to the French sociologist Gabriel Tarde, who was the first to suggest that the adoption of innovation follows a normal S-shaped distribution curve over time. He also argued that cosmopolitan experience is related to innovation. His strongest contribution was the indication of the process by which an opinion leader can influence others. Other topics researched by this tradition were the diffusion of a single innovation over a geographic area, the diffusion of innovation and contemporary social change, and the relationship of ecological factors (size of city, region, etc.) and the adoption process (Rogers and Shoemaker, 1971:52).

Rural sociology is one of the largest and most persistent traditions in the study of innovation diffusion. It dates from the 1920's when the U.S. Department of Agriculture first studied campaigns to encourage the adoption of agricultural innovations. The classical work in this field is Ryan and Gross' study of the diffusion of hybrid seed corn in the two small Iowa communities in 1942 (Ryan and Gross, 1943:15-24). This study influenced the methodology, findings, and interpretation of later studies. Since 1960, several U.S. rural sociologists have carried out research in other countries. Problems of agricultural development and such related topics as education, health and population growth have been the focus of these works. A frequent criticism of this tradition is how little attention it pays to sociological theories. According to critics, the studies lead to a raw empirical approach. The tradition's most recent activity is studies of extension education activities (Blaut, 1971:345; Saint and Coward, 1977).

Although research in education is a lesser tradition in terms of its contribution to the understanding of the diffusion of innovation, some current trends may be very useful. Most early studies were made at Columbia University's Teachers College by Paul Mot. The unit of analysis was then the school system, but later trends are more related to opinion leadership and innovations, perceived characteristics of innovations, and consequences of educational innovations. (Rogers and Shoemaker, 1971:58)

The diffusion tradition in medical sociology began in the 1950's. The first analyzed topics were new drugs, polio vaccine, and family planning methods in less developed nations. Columbia University's Bureau of Applied Social Research is one of the most active institutions in this field. The classical study in this tradition was carried out by the bureau in 1954 (Rogers and Shoemaker, 1971:62-64). It analyzed the diffusion of a new antibiotic that appeared in 1953. Three important findings were made by this research: the relationship between opinion leadership and innovativeness, the variables correlated with innovativeness for a different type of adopter unit, and the use of an objective measure of time of adoption.

Communication is the newest tradition in diffusion research, being recognized only after 1962. Many departments or institutes of communication are active in U.S. universities today training professional communicators and carrying out applied research. The transmission of technological ideas dealing with agricultural health, educational, and family planning innovations are studied. The advantage of this field is that it can analyze any type of innovation and is able to concentrate on the process of diffusion of the innovation rather than on the innovation itself. It is both a multidisciplinary and interdisciplinary approach (Katz, Levin and Hamilton, 1963:239; Rogers and Shoemaker, 1971:66-68).

The seventh tradition, marketing, emerged in the 1960's. Although it has strong roots in behavioral science and economics, it has made use of several techniques developed by other fields specially rural sociology. Most researchers in this field are professors in graduate schools of marketing who study the introduction of new products. Consequently, this field has some bias toward the innovation's source, rather than the potential adopters (Rogers and Shoemaker, 1971:68).

The eighth tradition, the geographic approach, deals primarily with innovation diffusion in which the main emphasis is on spatial variables: distribution of events in space and over time, spatial patterns of innovation diffusion, and the process that leads to a specific type of spatial pattern. The classic work in the field was done by Torsten Hagerstrand (Hagerstrand, 1967) in Sweden. In his initial work, Hagerstrand devised a simulation model using a probabilistic approach in which he attempts to demonstrate how information would probably be diffused over space given certain assumptions. With this work, Hagerstrand made three contributions: a conceptualization of the diffusion of innovation process; the development of a technique for operationalizing that conceptualization; and the identification of empirical regularities in diffusion (Brown, 1977:7).

Hagerstrand's model, which is known as "Monte Carlo Simulation" (Brown, 1977:10), has been used as a very important tool in the geographic studies related to the innovation diffusion process. According to Brown, three types of research are evident in this field: studies of the components of Hagerstrand's Operational Model to innovation diffusion, and developments in the Mathematical Portrayal of diffusion process (Brown, 1977).

Following the Hagerstrand pioneer work and taking into account these types of research, an enthusiastic group of geographers has continued developing this field. One of the more active of these groups is presently carrying out research in innovation diffusion at Ohio State University under the direction of A. Lawrence Brown. Some of the newest publications of this group are: The Innovation Diffusion Process in a Public Policy Context by A. L. Brown, 1978; Simulating the Spatial Diffusion of Innovation: A Gaming Experimental Approach by C.S. Graing and A.L. Brown, 1977; Innovation Diffusion and Development in a Third World Setting: The Case of the Cooperative Movement in Sierra Leone by R. Schneider, A. L. Brown, M.E. Harvey and J.B. Riddell, 1977; Diffusion Research in Geography, A Thematic Account by A.L. Brown, 1977; The Role of Diffusion Agencies in Innovation Adoption: A Behavioral Approach by M.A. Brown, 1977; Structural Effects on the Diffusion of Innovations by N. Lin and C. Melick 1977; and Innovation Establishment in a Rural Setting: Four Case Studies with Reference to a Theoretical Framework by M.A. Brown and L.A. Brown 1976. All these publications are part of the series "Studies in the Diffusion of Innovation Discussion Paper," which were issued by the Department of Geography at the Ohio State University.

B. Concepts and Definitions in the Diffusion Process

The elements acting upon the definition of the diffusion process can be major or minor depending upon researcher and study time. For the purpose of this study, the definition of the diffusion process is one which includes the following elements: innovation, communication channels, unit of adoption, time, and space. Thus, the diffusion process can be defined as the process by which an innovation is communicated to an adoption unit through time and in space. The components of this definition are briefly described in the next paragraph.

Innovation. An innovation is an idea, practice, or object perceived as new by a unit of adoption; it does not have to be an objectively new item (Morrill and Manninen, 1975:269). If the item seems new to the unit of adoption, it is an innovation. For instance, there could be a subjective newness. Any item has been an innovation at some time. Also, any innovation will not be an innovation to someone at some time. One other consideration is that the diffusion and adoption of all innovations are not necessarily desirable.

All innovations have particular characteristics, and depending upon these factors, as perceived by the adoption unit, each item has a different rate of adoption. The most important characteristics that influence the adoption of an innovation are: a) relative advantage: degree to which an innovation is perceived as better than what it supersedes; b) compatibility: degree to which an innovation is perceived as being consistent with existing values, experiences, and needs of the receiver; c) complexity: degree to which an innovation is perceived as difficult to understand and use; d) triability: degree to which an innovation may be experimented with on a limited basis; and e) observability: degree to which the results of an innovation are visible to the potential adopter (Thomas and Le Heron 1975:233; Rogers and Shoemaker, 1971:22-23).

Communication channels. Communication is the process by which messages are transmitted from a source to a receiver. This process takes place using channels as a means to reach the potential adoption unit. In all communication processes there are important elements such as frequency of transmission, type of channels, credibility of the source, and perceived meaning of the message which are among the relevant variables in the analysis of diffusion (Yapa,1975:164).

Frequency of transmission depends on the properties of the channels, the geometry of the network, and the effect of distance; the channels can be one of three types (Yapa, 1975:164;

Yapa and Mayfield, 1978:318): mass media channels, interpersonal channels, and a combination of both kinds. Sometimes, before the adoption unit can take action, the potential adopter needs to decode the message, interpret it, and select responses according to the credibility given to the source (Yapa, 1975:165).

Unit of adoption. The adoption unit can be an individual or a collectivity (group, town, city, country, etc.). The social system in which the innovation process is taking place has an important influence on the spread of the item. The norms, social status, and hierarchy of a social system act to impede or facilitate the diffusion and adoption of an innovation. Whether the norms are traditional or modern is a critical factor in this process. The opinion leadership of some persons is another factor ruling the process. The combination of these elements determines whether the innovation is accepted by optional, collective, or authority decision (Morrill and Manninen, 1975:269; Rogers and Shoemaker, 1971:40).

Time. This element, together with space, is most characteristic of the diffusion process since diffusion takes time and is accomplished in space. The time element is the factor that differentiates diffusion from simple communication and distribution (Katz, Levin, and Hamilton, 1963:241). For example, it took ten years for hybrid seed corn to reach almost complete acceptance in Iowa communities (Ryan and Gross, 1943:17). Time is an active component of at least three important concepts in diffusion: the innovation-decision process (Powell and Roseman, 1972:221-227), innovativeness (Yapa and Mayfield, 1978; Bowler, 1976), and an innovation's rate of adoption (Morrill and Manninen, 1975:270).

The innovation decision process can be seen as having four stages: knowledge, persuasion, decision, and confirmation. The classical work by Ryan and Gross (1943) shows that in the adoption of hybrid seed corn in Iowa, the knowledge stage was from 1935 to 1937, the persuasion stage from 1937 to 1939, the decision stage from 1939 to 1941, and the confirmation stage ended in 1944 when the farmers who had rejected the innovation discontinued the use of hybrid seed corn.

The concept of innovativeness is related to the degree to which an individual is relatively earlier in adopting new items than others in the same social system. According to this concept, a member of a social system can be classified in one of five adopter categories: innovators, early adopters, early majority, and laggards. The findings of many studies show that when the adopter categories are standardized and distributed according to the frequency distribution of the normal curve, these categories can be used as ideal types because the members of any normally distributed population show a fixed distribution among these five groups. In most cases, the members of the population are distributed in the following manner: innovators, 2.5 percent; early adopters, 13.5 percent; early majority, 34.0 percent; late majority, 34.0 percent; and laggards, 16.0 percent (Haggett, 1976; Knofie, 1976; Rogers and Shoemaker, 1971). Finally, the rate of adoption is the relative speed with which an innovation is adopted by a member of a social system.

Space. The spatial element in the diffusion process is the other paramount factor. All kinds of diffusion have some type of spatial manifestation over time. Thus, any item "is an innovation at different places at different times" (Presser, 1969:511). All innovation has its origin at a point in both time and space. While over time, a diffusion can be an expansion or relocation phenomenon, and the spatial dimension produces a contagious or hierarchical pattern. In some cases, it is possible to have a combination of contagious and hierarchical patterns, one at the local scale, and the other on a larger scale. A good example of this type of spatial pattern is the diffusion of the adoption of radio broadcasting in the U.S.A. (Gould, 1969:5). The diffusion of an innovation, taking into consideration the spatial viewpoint, can shift along a continuum from the micro (local) to the macro (regional, national or continental) viewpoint (Gould, 1969:5).

The contagious pattern, also called the neighborhood effect, takes place principally at the local level and, in this case, the frictional effect of distance plays an important role (Morrill and Manninen, 1975). When this kind of pattern is present, the innovation passes from a person or place to the nearest neighbor. Interpersonal communication channels are very useful so that one person "touches" the other, and in this contact spreads the innovation contagiously.

C. Models that Explain the Diffusion Process

Many models have been used to explain the diffusion adoption of innovation. They have gone from a step-flow model to a multi-steps flow model, to a marketing and infrastructural model. A brief discussion of several of these models is presented and the theoretical models underlying this research is discussed in more detail.

Hypodermic Needle Model. It was one of the first models dealing with communication and adoption of new items. It is based on the principle of stimulus-response, and it "pictured the mass media as a giant hypodermic needle, pecking and plunging at a passive audience" (Rogers and Shoemaker, 1971:203). This model is formed by the all-powerful mass media and the atomized audience which is connected to the media, but not to each other. In this model, the mass media are seen as direct, immediate, and all-powerful means for sending a message to the atomized masses which are waiting for it with nothing intervening. It is a one-step flow model. Some of the criticisms of this approach are that it is too simple, too mechanistic, and too gross (Brown, 1968; Yapa, 1976).

One-Step Flow Model. After the hypodermic needle model, a one-step flow model was used as a possible substitution. The new model has some differences from the old one: the media are not all-powerful; screening aspects of selective exposure, perception, and retention affect the impact of the message; and different effects can occur for various members of the receiving audience depending on the individual's socio-economic characteristics (Hanneman, G.J., T. Carroll, E.M. Rogers et al., 1969; Rogers and Shoemaker, 1971; Hudson, 1972).

Multi-Step Flow Model. This model is newer than the previous two and incorporates some of their elements. It does not call for any particular number of steps, and the potential adopter can obtain the innovation through channels (especially opinion leaders) or directly from the source. In this model, the exact number of steps depends on the goal of the sender, nature of the innovation, availability of mass media, extent of audience, and the message's salience to the receiving audience (Karlsson, 1958; Hanneman, G.J. et al., 1969; Carroll, 1969, Rogers and Shoemaker, 1971).

Traditional Model. Another approach explaining innovation diffusion is a combination of communication means and geographical variables which this writer called the traditional model. Most representative researchers are working in mass communications, rural sociology, marketing, and geography. Foster (1962), Hagerstrand (1967), Rogers and Shoemaker (1971), and Levitt and Walton (1974), are some of the best known exponents of this approach. The basic ideas of the traditional model are: the process by which an individual is persuaded to adopt; information flow; underlying spatial and temporal differences in adoption; geographic factors; and socio-economic characteristics (values, needs, beliefs, and attitudes) of the potential adopters.

In this approach, the process leading to the acquisition of the innovation as opposed to the acquisition of the information about the innovation has been given less attention. It also believes that diffusion depends principally upon a network of social communications (Brown, 1978:5). Brown (1975:185) says that Hagerstrand saw the diffusion process as a "hierarchy of networks of social communication through which an innovation filters from a few innovators to the general population." By the same token, adoption of innovation is a learning process in which the more active factors are flow of information, personal characteristics, intensity and frequency of messages, and "relationships between exposure to 'information' about the innovation and reduction of resistance to adoption" (Brown, 1968:11).

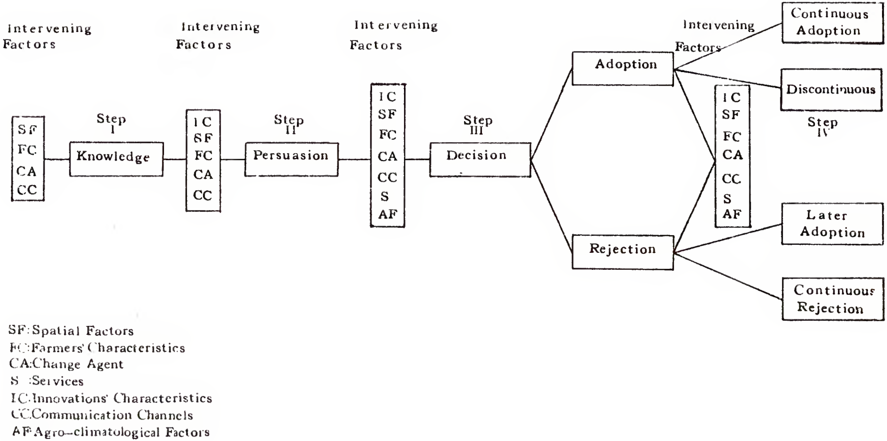
The author of this study believes that there are two reasons why none of the previous approaches has successfully explained the innovation diffusion process. First, the diffusion and adoption of an innovation can be analyzed like supply and demand functions (Brown, 1975:185), in which the adoption step is the demand side of the function and the processes and services that make the adoption decision possible are the supply function. Second, there are both infrastructure constrained diffusion and infrastructure independent diffusion (Brown, 1975:198; Brown and Brown, 1976). There are infrastructures which are associated with a given innovation; one example is water. This is a critical element for the new high-yield crop varieties. Since water is not available everywhere, and because the cost of this input varies widely from place to place, the potential adopter who has this resource or has it cheaper is more able to adopt the innovation than other potential adopters. Thus, where water is not available for everyone, a situation having infrastructure constraints exists. If the innovation is not affected by water, it can be seen as an infrastructure independent innovation relative to this element.

Taking into account the purposes and objectives of this research and the two reasons stated above, a broader approach must be taken. A new model has been developed by several researches in the last few years. This approach has found theoretical and empirical support in several works (Brown, 1975; Brown, 1968; Brown and Brown, 1975; Brown, Malecki and Spector, 1976; Brown and Lentnek, 1973; Griliches, 1975; Semple and Brown, 1976). The model developed by these researchers is the underlying framework for this task, and it is presented in the following paragraphs.

Marketing and Infrastructure Model. The basic assumptions of this approach are that information flow, personal characteristics, intensity and frequency of messages, reduction of physical resistances, and location are only some of the factors related to the diffusion process. This model shifts the emphasis from the characteristics of the potential adopter and the communication channels to a broader spectrum in which the diffusion and adoption of the innovation are related to all the traditional factors plus availability of the innovation itself, potential adopter need or desire, ability of the potential adopter to obtain the innovation, and related inputs, and infrastructure facilities. In this sense, the marketing and infrastructure approach is an integral model in which socio-economic, demographic, communication behavior, spatial dimensions and structural factors are taken into consideration to account for the diffusion and adoption of an innovation. The model also means that before the adoption can take place, three steps have to be taken in which the third is the focus of most of the other models. Brown et al. (1973) analyzed adoption as a single process itself.

The first two steps are related to the creation of diffusion infrastructure and presuppose the establishment of other public and private infrastructures which facilitate the diffusion and adoption processes (Brown, Malecki and Spector, 1976:100). The first step is the establishment of the diffusion agency which will distribute the innovation. According to these authors, the establishment pattern can be one of two: a single agency with many branches in different locations or, alternately, several agencies acting simultaneously in the same space. The second step is the formulation and implementation of a strategy to induce adoption among the population in the service area. The strategy has to take into consideration: a) the potential adopter's need or desire, ability to get and use information and economic capability to obtain the innovation and all related inputs; b) the infrastructure facilities, such as physical facilities and technical and commercial services.

The third and last step is the adoption decision process. Before this decision is made, several intervening factors play different roles (see Figure 4).



*This figure is a modified version of the original figure published in: Rogers and Shoemaker, 1971:102

Figure 4. Steps Illustrating Intervening Factors in the Innovation-Decision Process*

Figure 4 shows that not all the intervening factors (explanatory variables, see Table 5 in Chapter III) acting in the different steps of the innovation-decision process are the same. Before each step can take place, some conditions have to be fulfilled, in this sense, the knowledge function needs the concurrence of spatial factors (SF), farmers' characteristics (FC), change agent (CA), and communication channels (CC). In addition to the latter factors, the persuasion function depends upon the innovations' characteristics (IC). Steps three and four, decision and confirmation functions, occur after other two elements are added to the foregoing factors: Services (S) and agro-climatological factors (AF). The agro-climatological factors were dropped from the study in the collection stage due to unavailability of accurate information.

Since with this approach, the researcher understands the various processes and the elements underlying the diffusion patterns rather than the patterns alone, the conceptual construction and operational models derived from it are more real and powerful. This marketing and infrastructure approach is also a useful device for private enterprises and public policy and planning activities. Since the goals of this study are to reach conclusions which can be used as foundations for policy development in extension education related to the rice crop, this author thinks that the marketing and infrastructural approach is the best model to frame the present work.

After the presentation of the dissertation's theoretical framework in which eight innovation research traditions, concepts and models related to the innovation diffusion process were analyzed. Chapter III will discuss the research purpose, scope and the variables and hypotheses supporting the research work.

CHAPTER III
RESEARCH PURPOSES AND SCOPE, VARIABLES AND HYPOTHESES

The topics covered in Chapter III are the foundations of this study. While the research purposes set the goals to follow, the research scope placed boundaries to the type and size of the study population. At the same time, a group of elements (explanatory variables), which had shown interrelationship with the knowledge and adoption functions, were selected and discussed according to the findings of several innovations' diffusion investigations. By the same token, the new rice technology was defined also and it represented the study problem variables. Finally, relationships among explanatory and problem variables were stated under the names of general and specific hypotheses.

A. Research Purposes and Scope

Because the gap between developed and developing countries is partially a result of the level of science and technology each uses, the link between science and technology and the establishment of national development is clear and necessary. At the same time, the relationship between diffusion and adoption of innovation and agricultural modernization and between agricultural modernization and agricultural development is also well established. By the same token, in countries like the Dominican Republic, socio-economic development is very difficult without the development of the agricultural sector.

For these reasons this research seeks to facilitate the improvement of the agricultural sector by concentrating on rice, which is one of the most important crops in the country. Starting from a theoretical base as well as empirical experiences, most of the factors related to the diffusion and adoption processes are studied so key variables are selected and analyzed. Then, the final goal of the research is the development of a model which can explain the main factors related to the diffusion and adoption of innovations among rice producers. Consequently, this writer hopes that such a model would be useful in improving the extension education services in the Secretariat of Agriculture in the Dominican Republic.

A theoretical approach consisting of a marketing and infrastructural model was tested through the use of field study's data. Then, from the observed model, conclusions and recommendations were reached as a way to offer foundations which should be basic in policy decision, development, and implementation of programs dealing with rice production.

The study was made at the national level but only with farmers working in areas under land reform programs. Although there are 10,168 rice producers belonging to land reform programs, which control 48.0 percent of the total rice area (69,357 has.) in the country, only 6,723 cases had available information at the Dominican Agrarian Institute when this study was being carried out. Farmers with available information were those producers who received public credit in the last planting season (from December 1977 to May 1978). These 6,723 cases (22.3 percent of the total rice producers in the country and 66.1 percent of the rice farmers working on public land) were used as the study population. A sample of 478 cases were drawn from the 6,723 producers representing the study population. The farmers in the sample are distributed in 95 projects which represent 57.6 percent of the total number of projects growing rice under land reform programs (see Table 2).

Although the rice producers included in the study sample are not an exact representation of all the rice farmers working at the national level, there are four reasons which justify studying only part of the rice producers working on government lands: a) the entire population related to this crop is too large for a dissertation field project such as this one; b) basic information needed to choose the sample is not available for all 30,082 cases at the national level, but is accessible only for 6,723 farmers working on government projects; c) because the producers belonging to the Dominican Agrarian Institute are being administered by government agencies which means that the research findings can be applied more broadly and effectively to the small producers; and d) that those small producers are the farmers who most need this kind of information.

In short, from the 478 cases representing the research sample, 437 producers were interviewed in the field study. The information collected and analyzed in this dissertation typifies those rice producers working in public land that received credit during the first cropping season of 1978.

TABLE 2

DISTRIBUTION OF GOVERNMENT RICE PROJECTS AND PROJECTS IN THE STUDY POPULATION

REGIONS AND PROJECTS	NUMBER
NORTH REGION:	
Total Projects	66
Projects in the study population	24
CENTRAL CIBAO:	
Total Projects	85
Projects in the study population	65
SOUTH REGION:	
Total Projects	8
Projects in the study population	1
EAST REGION:	
Total Projects	6
Projects in the study population	5
Total number of government projects	165
Projects in the study population	95

B. Variables and Hypotheses

1. Variables

Although innovation diffusion has been studied by many people in several places and times, one of the best known research works is that of Hagerstrand: Innovation Diffusion as Spatial Process (Hagerstrand, 1967). In this pioneering study, Hagerstrand analyzed the relationships between three agricultural technologies (pasture grazing, control of bovine tuberculosis and soil mapping) and the parameters that are related to their spread. In spite of the fact that among the variables used by Hagerstrand to explain the diffusion of these innovations were distance between original and potential adopters and socio-economic and physical barriers, his approach is principally an information-based model; the network of social communication (public or private information) was the paramount factor associated with the acceptance of the new technology (Brown, 1977:7; Blaut, 1977: 344).

Other researchers and studies that have emphasized explanatory variables related to the innovation decision process are: a) Rogers and Shoemaker, who cited the attributes of innovations, characteristics of potential adopters, agents of change, opinion leadership, and communication channels as the main variables associated to the diffusion and adoption of new technology (Rogers and Shoemaker, 1971); b) Gould, who tried the diffusion of innovation using the spatial dimension and different kind of barrier-like factors which explain this phenomenon (Gould, 1969); c) Brown and his co-writers examined the spread and adoption of an innovation and saw this as a process dependent upon spatial dimensions, communication behavior, socioeconomic, demographic and structural factors (Brown et al., 1976; Brown, 1975; Brown and Brown, 1976): and d) the International Rice Research Institute (IRRI) has found that several factors are related to the spread and use of an innovation. In this case, the studies have been undertaken with technology belonging to rice cultivation. Among the elements that improve the diffusion and adoption of the released technology, the IRRI cited: water supplies, soil and climatic conditions, availability of inputs (fertilizers, insecticides, and herbicides); extension, training, transportation, credit, labor and machinery services; and price incentives (IRRI, 1975; Chandler, 1979).

Taking into account the above cited studies which have discussed the innovation decision process as well as the experience of the writer in relation to the rice situation in the Dominican Republic, fifty one variables were selected to explain the knowledge and adoption functions. These fifty one elements received the name of explanatory variables and they represent the innovations' characteristics, location factors, farmers' characteristics, change agent, services, and diffusion channels.

All the explanatory variables used in this research were defined operationally in Table 3. A flow chart

TABLE 3

DEFINITIONS OF EXPLANATORY VARIABLES

Innovations' Characteristics

1. Profitability: Economic benefits (yield, profitability) of the new technology.
2. Compatibility: Comparison between new and old technology.
3. Complexity: Ease of understanding of new technology.
4. Trialability: Applicability of the new technology.
5. Observability: Whether or not the results of the new technology are visible in relation to the results of the old technology.

Location

6. Change agent (CA) location: Location in relation to the farm.
7. Demonstration plots' location: Location in relation to the farm.
8. Credit services location: Location in relation to the farm.
9. Inputs location (fertilizers, pesticides, etc.): Location in relation to the farm.
10. Storage location: Location in relation to the farm.
11. Buyers' location: Location in relation to the farm.

Farmers' Characteristics

12. Farmer age: In years.
13. Farmer dependents: Number of relatives depending economically upon the farmer.
14. Farm size: In hectares.
15. Farmer social status: In relation to other farmers in the project.
16. Farmer educational level: Degree of schooling.
17. Intensity of cultivation: Commercial vs. subsistence.
18. Economic capacity of farmer: Origin of money used for production.
19. Farm specialization: Number of crops planted in the farm.
20. Empathy: Participation of farmer in groups, meeting, and community activities.
21. Dogmatism: Attitude toward change in traditions, values, and practices of community, groups and persons.
22. Rationality: Frequency with which the farmer makes work plan and budget before the start of the harvest season.
23. Attitude toward change: Farmer's attitude to testing new technology.
24. Attitude toward risk: Farmer's attitude to trying something which could have positive results but whose results are not certain.
25. Attitude toward credit: Whether or not the farmer thinks

that using credit is positive or negative for farm activities

26. Attitude toward science and technology: Whether or not the farmer thinks they are useful to people.
27. Level of aspiration: Value given to education, work, and living conditions of farmer's children.
28. Social participation of farmer: Amount of meeting and exchange of ideas between farmer and peers and others at the local and regional levels.
29. Farmer local integration: Degree of identification and solidarity with partners and members of his community.
30. Farmer cosmopolitan attitude: Whether the farmer wishes to live in a city.
31. Meeting of a farmer with a CA: Whether the farmer thinks the CA visits often enough.
32. Mass media exposure of farmer: Frequency of contacts with radio, TV, newspapers, and magazines.
33. Farmer interpersonal communication channels exposure: Frequency of meetings, conferences, short courses, workshops, field activities, demonstrations, educational films, etc., experience.
34. Degree of opinion leadership: Number of persons who ask the farmer for advice.

Change Agent

35. CA effort: Whether the farmer thinks the CA is doing enough to help him.
36. CA knowledge: Whether the farmer thinks the CA has enough information about the new technology.
37. CA orientation: Client vs. agency: Whether the farmer thinks the CA works more for the agency's or farmer's interests.
38. CA homophile with clients: Whether the farmer thinks the CA's attitudes, beliefs, and conduct are similar to or different from his own.
39. CA empathy with clients: Whether the farmer thinks the CA's way of life is similar to his own.
40. CA social status among clients: Farmer's perception of CA's social status.
41. CA social participation with clients: Farmer's perception of CA's social participation in the farm community.
42. CA relation with opinion leaders: Farmer's perception of CA's leadership in the community.
43. CA credibility: Farmer's perception of CA's credibility among the project's farmers.

Services

44. Credit services: Amount, opportunity, and conditions in which the agricultural bank extends credit.
45. Seed services: Amount, opportunity, and conditions under which high-yield varieties are sold to producers.

46. Fertilizers, pesticides, herbicides, rodenticides, machinery, and irrigation and drainage services: Amount, opportunity, and conditions under which such services are available to producers.
47. Labor services: Availability and conditions of labor.
48. Harvest, transportation, drying, and storage services: Availability and conditions of services.
49. Profitability: Relationship between production cost and net profit.

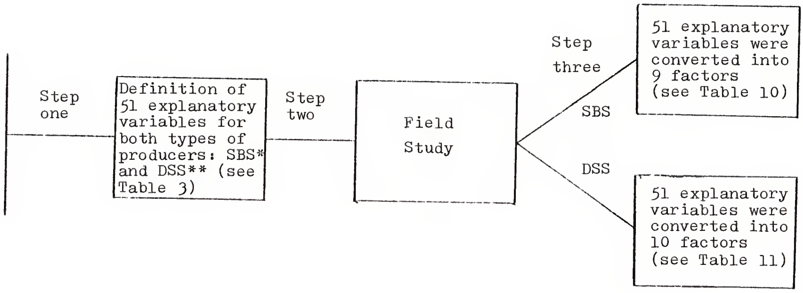
Diffusion Channels

50. Mass media channels: Information about agricultural programs available from radio, films, magazines, and other publications.
51. Interpersonal channels: Amount of times that the farmer meets with his partners or other persons to analyze agricultural topics.

illustrating these variables from the definition to the transformation into factor scores is also presented in Figure 5. The definitions offered in Table 3 came from theoretical results and empirical findings which were tested by the researchers. Figure 5 shows that after the definition of the elements and the field study, the fifty one explanatory variables were transformed into factor scores according to categories of rice producers. Two kinds of farmers were found: they are producers using the seedbed system and producers using the direct seed system. In the first case, the fifty one explanatory variables collapsed into 9 factor scores (see Table 10 in Chapter V), in the second case, the fifty one variables became 10 factor scores (see Table 11 in Chapter V).

All farmers cultivating rice in the Dominican Republic can be classified either as producers who use the seedbed system or those who use the direct seed system. The difference between one type and the other is whether they plant the seed rice directly on the field or they make a seedbed first and some time later, transplant the seedling to the field.

In addition to this basic difference, and according to this study and the experience of researchers, extension agents and others working at the Juma Experimental Station, each category of rice farmers has distinct characteristics. Producers using the seedbed system can be characterized as: a) working in individual projects; b) less technically


Step one
Definition of 51 explanatory variables for both types of producers: SBS* and DSS** (see Table 3)
Step two
Field Study
Step three
SBS
DSS
51 explanatory variables were converted into 9 factors (see Table 10)
51 explanatory variables were converted into 10 factors (see Table 11)

*SBS: Seedbed System
**DSS: Direct Seed System

Figure 5. Flow Chart Illustrating Explanatory Variables from Definition to Transformation

advanced producers than direct seed farmers; c) usually working farms are smaller than 5 hectares; d) making heavier investment per unit of land because the system of rice production needs more intensive use of tools and labor; and e) needing good drainage and level land. Producers using the direct seed system can be characterized as: a) working in collective projects of up to 256.8 hectares; b) being more technically advanced producers; c) having lower production cost per unit of land because this system needs less labor and has a larger scale of production; d) having more technical assistance from extension agents and more security about credit and inputs. The characteristics for each kind of producer were taken into consideration in the analysis and interpretation of the findings.

Both kinds of producers know and are using rice varieties, cultural practices, and inputs and services which represent the current rice technology. At the same time, after more than fifteen years of research in the country, the Juma Experimental Station had developed high-yield varieties of rice which need specific cultural practices, inputs, and services in defined amounts, time, and methodology of application. The new varieties and related recommendations ("technological package") released by the station in the last ten years were discussed between this writer and the technicians belonging to the station several times. During these work sessions, the "technological package" was defined operationally element by element; those elements represent the problem variables of this study.

The number of problem variables is different for each category of rice producers because the agricultural activities change from one type of farmer to the other. While producers with the seedbed system had fifty problem variables (see Table 4), the producers with the direct seed system had only 37 problem variables (see Table 5). In both cases, the problem variables (50 and 37) were recorded following two concepts: the adoption score (rate at which a farmer adopts the innovations) and degree of knowledge about innovations (rate at which a farmer is informed about innovations). After the field study, the original problem variables (50 and 37) were changed (through the account of the number of negative answers given by each single producer) to two problem variables: the adoption score and the degree of knowledge about innovations belonging to each single farmer (see Figure 6). In an additional step, the values representing the adoption score and degree of knowledge about innovations by single farmers (which have to be from 1 to 50 in the case of SBS and from 1 to 37 in the case of DSS) were transformed to percentages through dividing the values (number of negative answers of a single farmer) representing the adoption score and degree of knowledge about innovations for each single farmer by the total value (50 or 37) that each single farmer could have if he knew and used all the recommendations released by the Juma Experimental Station (50 in the case of SBS and 37 in the case of DSS). For example, when a

TABLE 4

DEFINITIONS, VALUES, AND/OR ANSWERS OF PROBLEM VARIABLES FOR FARMERS WITH SEEDBED SYSTEM

1. High-yield varieties: Juma-1, IR-5, IR-6, CICA-4, Juma-32, Juma-57, Juma-58, and Juma-60 (Tanioka).
2. Plowing, cross-plowing and disking: the same.
3. Depth to disk the soil: From 18 to 22 centimeters.
4. Use of contour to level land: Yes
5. Dry or wet leveling: Dry.
6. Devices used to level contours: Special devices (no shovel).
7. Stage in which "fangeo"* is made: During leveling.
8. Date to "fangeo" after plowing: From 2 to 3 weeks after plowing, cross-plowing and disking.
9. Devices to disk the soil: Disk with dump.
10. Devices to level land: Tractor's devices.
11. Methods to do seedbed: from 1.5 to 2.3 meters long.
12. Date to do seedbed: From December 15 to February 28.
13. Amount seed/area for seedbed: From 32 to 48 quintals/hectare.
14. Conditions to plant seeds in seedbed: Dry seed.
15. Date of first irrigation of seedbed: Two days after seed planted.
16. Area of seedbed relative to area to be planted: From 4 to 5 percent.
17. Amount of fertilizer/area used in seedbed:
    Formula 15-15-15: From 1.60 to 7.36 quintals/hectare.
    Formula 12-24-12: From 1.92 to 9.28 quintals/hectare.
18. Date to apply fertilizer to seedbed: From 7 to 10 days after sowing seed.
19. Methods of applying fertilizer: By hand and in one application.
20. Amount of pesticide/area in seedbed:
    Furadan: From 0.32 to 0.40 quintals/hectare.
    Bim: 3 gallons/hectare.
    Hinosan: 3 gallons/hectare.
    Kasumin: 3 gallons/hectare.
    Endrin: 2.75 gallons/hectare.
21. Date to apply pesticides to seedbed: One week after germination or later, when necessary.
22. Methods of applying pesticide: Manual pump, haversack, airplane.
23. Date to prepare land for transplants from seedbed: Before or together with seedbed.
24. Date to transplant if first harvest: From 35 to 45 days.

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*"fangeo" is a land-leveling procedure. It is performed when the land is flooded.

25. Methods of planting: In vertical position.
26. Number of holes/area: From 16 to 20.
27. Number of plants/hole: From 4 to 5.
28. Depth to set plants: From 1 to 2 inches.
29. Time between putting out the seedlings and transplanting: Two days.
30. Number of days to apply water after transplant: No less than 3 days.
31. Amount of water given after transplant: From 1.5 to 2 inches.
32. Number of fertilizations applied after transplant: Three
33. Date of first fertilization: From 7 to 10 days after the transplant.
34. Date of second fertilization: From 21 to 23 days after the transplant.
35. Date of third fertilization: From 20 to 25 days before the ear emerges.
36. Date to withdraw water before inputs application: From 1 to 3 days.
37. Date to irrigate again: From 1 to 2 days after application.
38. Amount of fertilizer in first application:
    Formula 15-15-15: From 5.60 to 6.40 quintals/hectare.
    Formula 12-24-12: From 7.20 to 8.16 quintals/hectare.
    Formula 13-13-13: From 6.72 to 7.20 quintals/hectare.
    Formula 16-20- 0: From 5.60 to 6.50 quintals/hectare.
39. Amount of fertilizer in second application:
    Formula 15-15-15: From 5.60 to 6.40 quintals/hectare.
    Formula 12-24-12: From 7.20 to 8.16 quintals/hectare.
    Formula 13-13-13: From 6.72 to 7.20 quintals/hectare.
    Formula 16-20- 0: From 5.60 to 6.40 quintals/hectare.
40. Amount of fertilizer in third application:
    Urea: From 0 to 0.98 quintal/hectare.
    Sulfate of ammonia: From 0 to 2.24 quintals/hectare.
41. Methods of application: By hand or airplane.
42. Amount of pre-emergent herbicide/area:
    Machete: 1.50 gallons/hectare.
    Bolero: 0.55 gallon/hectare.
    Tordan: From 2 to 2.50 gallons/hectare.
    Stan: 0.25 gallon/hectare.
43. Date to apply herbicide after transplant: From 4 to 7 days.
44. Amount of herbicide/area:
    2 4-D: From 2 to 2.70 gallons/hectare.
    Stam f-34: 0.25 gallon/hectare.
    Tordan: From 2 to 2.70 gallons/hectare
45. Date to apply herbicide: When the weeds have from 1 to 3 leaves.
46. Amount of fungicide/area:
    Benlate: From 0.55 to 0.75 hectare per 0.01 quintal.
    Kasumin: 3.25 hectares/gallon.

Bla-s: 3.25 hectares/gallon.
Hinosan: 3.25 hectares/gallon.
Kitazin: 3.25 hectares/gallon.

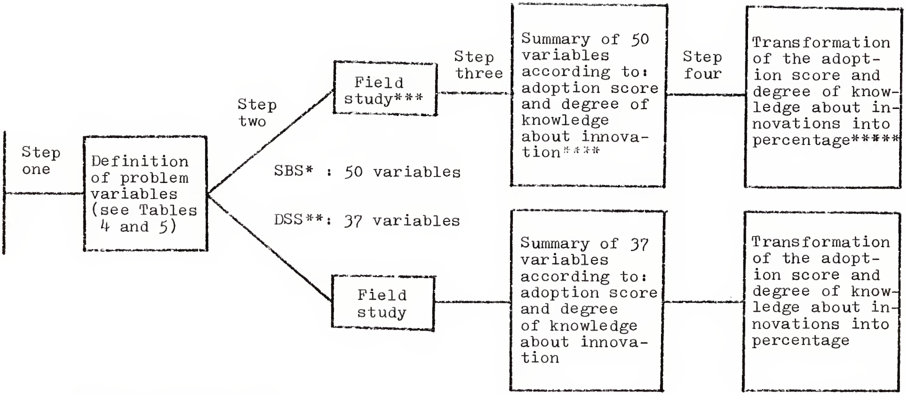
47. Amount of pesticide/area:
    Endrin: 3.75 hectares/gallon.
    Asodrin: 6.25 hectares/gallon.
    Sevin: 6.25 hectares/gallon.
    Furadan: From 0.75 to 1.16 hectares/quintal.
48. Date to apply pesticide: When the disease is present.
49. Date to dry land before harvest:
    If the soil has no clay: From 5 to 7 days before harvest.
    If clay soil: From 10 to 15 days before harvest.
50. Maturity of grain to be harvested: From 70 to 80 percent of maturity.

TABLE 5

DEFINITIONS, VALUES, AND/OR ANSWERS OF PROBLEM VARIABLES FOR FARMERS WITH DIRECT SEED SYSTEM

1. High-yield varieties: Juma-1, IR-5, CICA-4, Juma-32, Juma-57, Juma-58, and Juma-60 (Tanioka).
2. Plowing, cross-plowing and disking: The same.
3. Depth to disk the soil: From 18 to 33 centimeters.
4. Use of contour to level land: Yes.
5. Dry or wet leveling: Dry.
6. Devices used to level curves: Special devices (no shovel).
7. Stages in which "fangeo" is made: During leveling.
8. Date of "fangeo" after plowing: From 2 to 3 weeks after plowing, cross-plowing and disking.
9. Devices used to disk the soil: Disk with dump.
10. Devices to smooth land: Tractor's devices.
11. Amount of seed/area: From 2.25 to 2.56 quintals/hectare.
12. Methods of planting seeds: Manually or by airplane.
13. Date to plant if only one harvest: From December 15 to July 30.
14. Date to plant first harvest if two harvests: From December 15 to February 28.
15. Date to plant second harvest if two harvests: From June to July 15.
16. Conditions to plant seeds:
    If land is wet: germinated seed.
    If seed is not germinated: Land with 1 to 2 inches of water.
17. Date of first irrigation: From 8 to 10 days after seed is sown.
18. Amount of water in first irrigation: Less than one inch.
19. Amount of water for adult plants: Less than five inches.
20. Number of applications of fertilizer: Three.
21. Date of first fertilization: From 30 to 40 days after sowing.
22. Date of second fertilization: From 50 to 60 days after sowing.
23. Date of third fertilization: From 20 to 25 days before the ear emerges.
24. Date to withdraw water before inputs application: From 1 to 3 days.
25. Date to irrigate again: From 1 to 2 days after application.
26. Amount of fertilizer in first application:
    Formula 15-15-15: From 5.60 to 6.40 quintals/hectare.
    Formula 12-24-12: From 7.20 to 8.16 quintals/hectare.
    Formula 13-13-13: From 6.72 to 7.20 quintals/hectare.
    Formula 16-20- 0: From 5.60 to 6.40 quintals/hectare.

27. Amount of fertilizer in second application:
    Formula 15-15-15: From 5.60 to 6.40 quintals/hectare.
    Formula 12-24-12: From 7.20 to 8.16 quintals/hectare.
    Formula 13-13-13: From 6.72 to 7.20 quintals/hectare.
    Formula 16-20- 0: From 5.60 to 6.40 quintals/hectare.
28. Amount of fertilizer in third application:
    Urea: From 0 to 0.98 quintal/hectare.
    Sulfate of ammonia: From 0 to 2.24 quintals/hectare.
29. Methods of application: Manually or by airplane.
30. Amount of pre-emergent herbicide/area:
    Machete: 1.50 gallons/hectare.
    Bolero: 0.55 gallon/hectare.
    Tordan: From 2 to 2.50 gallons/hectare.
    Stan: 0.25 gallon/hectare.
31. Amount of herbicide/area:
    2,4-D: From 2 to 2.70 gallons/hectare.
    Stam f-34: 0.25 gallon/hectare.
    Tordan: From 2 to 2.70 gallons/hectare.
32. Date to apply herbicides: When the weeds have from 1 to 2 leaves.
33. Amount of fungicide/area:
    Benlate: From 0.55 to 0.75 hectare per 0.01 quintal.
    Kasumin: 3.25 hectares/gallon.
    Bla-s: 3.25 hectares/gallon.
    Hinosan: 3.25 hectares/gallon.
    Kitazin: 3.25 hectares/gallon.
34. Amount of pesticide/area:
    Endrin: 3.75 hectares/gallon.
    Asodrin: 6.25 hectares/gallon.
    Sevin: 6.25 hectares/gallon.
    Furadan: From 0.75 to 1.16 hectares/gallon.
35. Date to apply pesticides: When disease is present.
36. Date to dry land for harvest:
    If soil has no clay: From 5 to 7 days before harvest.
    If clay soils: From 10 to 15 days before harvest.
37. Maturity of grain to be harvested: From 70 to 80 percent of maturity.


Step one
Definition of problem variables (see Tables 4 and 5)
Step two
SBS* : 50 variables
DSS**: 37 variables
Field study***
Field study
Step three
Summary of 50 variables according to: adoption score and degree of knowledge about innovation****
Summary of 37 variables according to: adoption score and degree of knowledge about innovation
Step four
Transformation of the adoption score and degree of knowledge about innovations into percentage*****
Transformation of the adoption score and degree of knowledge about innovations into percentage

*SBS: Seedbed System

**DSS: Direct Seed System

***The problem variables were recorded according to two concepts: the adoption score and the degree of knowledge about innovations.

****The negative answers given by each producer were summarized to obtain the adoption score and the degree of knowledge about innovations.

*****The transformation was made by dividing the score of each producer by his total number of answers.

Figure 6. Flow Chart Illustrating Problem Variables from Definition to Transformation

farmer has a value of 10 points in the first transformation, that means he is using 40 (if SBS) of the 50 innovations he can potentially use. In the second transformation (the change to percentages), the same farmer has a value of 0.20.

2. Hypotheses

According to the findings of several authors and researchers (Rogers and Shoemaker, 1971; Brown, 1975; Brown, 1977; Brown and Brown, 197 ; Gould, 1969; IRRI, 1975; Chandler, 1979; Schramm and Lerner, 1976; Diaz Berdenave, 1977; Stevens, 1977; Hagerstrand, 1967) this author can infer that there are interrelations among the 51 explanatory variables and the 50 or 37 problem variables. These scientists present theoretical results and empirical findings which show that the explanatory variables can be used as factors which explain the variance of the problem variables. Taking into consideration these results, a number of hypotheses were formulated as foundations to the development of this study.

Since the problem variables were measured following the adoption score and degree of knowledge about innovations, the hypotheses were stated using the phrases "degree of knowledge" and "degree of adoption." Both knowledge and adoption were related to the new technological package that the Juma Experimental Station developed and introduced to the rice producers.

Two types of hypotheses were analyzed in the study: general and specific hypotheses. The former are broad enough to be used as an introduction to the latter and to establish the hierarchy of the explanatory variables. The latter are specific enough to link the innovations or problem variables to the explanatory factors or explanatory variables.

There are hypotheses in which the relationship among the explanatory and problem variables are positive. In other cases, the relationship are negative. Some hypotheses represent the interrelationships between a simple explanatory variable and the two problem variables (the adoption score and degree of knowledge about innovations), while other statements link more than one explanatory variable to the innovative ability of the rice producers.

The two general hypotheses formulated say that:

1. Attributes of the innovations; location factors; farmers' characteristics; change agents' characteristics; amount, quality, and quantity of services and inputs offered; and diffusion process channels are all relevant factors associated with the degree of knowledge and adoption of new varieties, practices, or products.
2. The factors referred to in the first general hypothesis have different levels of association with the degree of knowledge about and adoption of new technology. The importance of each factor in explaining knowledge about and adoption of an innovation may or may not rank in the order in which they are listed in the first hypothesis.

There are twenty-five specific hypotheses which state that:

1. The relative advantage of a new variety, practice, or product, as perceived by the farmer, is positively related to degree of knowledge and adoption.
2. The compatibility of a new variety, practice, or product with current values, beliefs, practices, and products, as perceived by the farmer, is positively related to degree of knowledge and adoption.
3. The triability of a new variety, practice, or product as perceived by the farmer, is positively related to the degree of knowledge and adoption.
4. The complexity of a new variety, practice, or product as perceived by the farmer, is negatively related to the degree of knowledge and adoption.
5. The observability of a new variety, practice, or product as perceived by the farmer, is positively related to the degree of knowledge and adoption.
6. The location of the change agent relative to any farm is positively related to the degree of knowledge about and adoption of a new variety, practice, or product.
7. The location of the research center and demonstration plot relative to any farm is positively related to the degree of knowledge about and adoption of a new variety, practice, or product.
8. The location of services and inputs relative to the farm is positively related to the degree of knowledge

about and adoption of a new variety, practice, or products.

9. The location of drying, storage, and buying facilities relative to any farm, is positively related to the degree of knowledge about and adoption of a new variety, practice, or product.
10. Farmers with a higher degree of knowledge about and adoption of a new variety, practice, or product, tend to be younger, more educated, and of higher social status than farmers with a lower degree of knowledge about and adoption of the innovation.
11. Farmers with a higher degree of knowledge about and adoption of a new variety, practice or product, have farms of medium size (about 3.5 hectares), have a commercial rather than subsistence orientation, have greater opportunity to acquire credit from the institutional system, and have farms with rice alone and with a single variety of rice.
12. Farmers with a higher degree of knowledge about and adoption of a new variety, practice, or product, tend to have more empathy with the change agent and other farmers, less dogmatic attitudes, more rational approaches to decision-making, more openness to change, risk, and technical and scientific knowledge, a higher level of aspiration in relation to education, occupation, and income than do the farmers with a lesser degree of knowledge about and adoption of innovation.

13. Farmers with a higher degree of knowledge about and adoption of a new variety, practice, or product, tend to participate more socially, be more integrated into the social system, have more cosmopolitan attitudes, have more contacts with the change agent, experience more exposure to mass media and interpersonal communication channels, and express a higher degree of opinion leadership than farmers with a lesser degree of knowledge about and adoption of innovation.
14. The degree of change agent effort, in terms of contacts with farmers, is positively related to the degree of knowledge about and adoption of innovations.
15. The degree of change agent knowledge about the new variety, practice, or product, is positively related to the degree of knowledge about and adoption of the innovation by farmers.
16. An orientation on the part of the change agent toward the farmer is positively related to the degree of knowledge about and adoption of a new variety, practice, or product.
17. The change agent's empathy with farmers' attitudes, beliefs and behavior is positively related to the degree of knowledge about and adoption of a new practice, variety, or product.
18. The degree of change agent's social status and social participation among farmers is positively related to

the degree of knowledge about and adoption of a new variety, practice, or product by farmers.

19. The degree of change agent's work among community leaders is positively related to the degree of knowledge about and adoption of a new variety, practice, or product.
20. The degree of change agent's credibility among the farmers is positively related to the degree of knowledge about and adoption of a new variety, practice, or product by farmers.
21. The amount, availability, and conditions of credit offered to farmers are related to the degree of knowledge about and adoption of a new variety, practice, or product.
22. The price, quality, quantity, and availability of inputs are related to the degree of knowledge about and adoption of a new variety, practice, or product.
23. Transportation, drying, and storage facilities are related to the degree of knowledge about and adoption of a new variety, practice, or product.
24. The profitability of rice production is related to the degree of knowledge about and adoption of a new variety, practice, or product.
25. Mass media channels are relatively more important in the knowledge function, and the interpersonal channels are relatively more important in the adoption function of a new variety, practice, or product.

Both general and specific hypotheses were checked against the field study results as a way to know whether or not they were supported by the technological current situation among rice producers in the Dominican Republic. In this sense, the correlation between one or a group of explanatory variables and the adoption score and degree of knowledge about innovations was tested in order to accept or reject the relationships stated in the above hypotheses.

CHAPTER IV
METHODOLOGY AND SAMPLING PROCEDURES

After the presentation and discussion of the variables and hypotheses of this research, there follows a discussion of the methodology and sampling procedures used to analyze the data representing both the explanatory and problem variables. The first topic discussed is the measurement of the research variables, then, the sampling procedures and field study are analyzed. The next section is dedicated to data processing work which had three main elements: correlation, factor, and regression analyses. Finally, the study's limitations are discussed in the final part of this chapter.

A. Measurement of Variables and Construction of the Questionnaire

The study showed in Chapter III that the problem variables are divided into two categories (see Tables 4 and 5, Chapter III): one category represents innovations spread among rice producers with the seedbed system, while the second category consists of producers with a direct seed system. In both cases, the problem variables were designed with the help of the researchers and other technicians working at the Juma Experimental Station. These people determined and defined all the new technology related to the high-yield variables and that was the "technological package" released by the station among the rice producers.

The problem variables were used to develop a questionnaire which was implemented in the field study. All variables were stated in the questionnaire following two concepts: the adoption score and degrees of knowledge about innovation. For instance, the answers given by the farmers during the administration of the questionnaire were recorded according to those two concepts. Therefore, the adoption score and degree of knowledge about the released innovations were measured by assigning a numerical value of one (1) when the farmer was using or was informed about the innovation, and a value of zero (0) for non-adoption or non-information. In cases where the farmer was using the innovation, it was assumed that he knew about it. For instance, the question about degree of knowledge was not applied but the information belonging to this question was recorded as a positive answer or with value of one (1).

Following the above described procedure, new technology (or the problem variables) spread by the Juma Experimental Station was recorded according to the adoption score and degree of knowledge. These two concepts were the elements used in processing and reducing the study data; then, the original 50 problem variables relating to the seedbed system and the other 37 problem variables describing the direct seed system were summarized into two variables which represented the adoption score and the degree of knowledge about innovations.

The 51 explanatory variables discussed in Chapter III (see Table 3), and which were defined using theoretical knowledge and empirical experiences, were measured using an ordinal scale that ranks from one (1) to five (5). In all variables, smaller numbers represent better knowledge or higher rates of adoption of the innovations. Three (3) is an intermediate position, and four (4) and five (5) represent lower conditions of knowledge about and adoption of the released technology.

When the explanatory variables were formed into questions, they were arranged in such a way that the farmer gave his personal appraisal of the situation. Thus, the answer represents the personal interpretation of the subject. For example, to measure the concept of "profitability or relative advantage of the innovation," the farmer was asked: "Do you believe that the economic benefits (yield, cost/benefit relationship) of the new varieties and related recommendations that you received from the change agent are: a) much better than the old varieties and recommendations, b) better than the old varieties and recommendations, c) the same as the old varieities and recommendations, d) worse than the old varieties and recommendations, e) or much worse than the old varieities and recommendations?"

The interview procedure used to collect the data in the field study was a questionnaire which contained both the problem and explanatory variables. The questionnaire has three parts: the first section contains general information about location, socio-economic conditions, time of interview, and name of the farmer. Information regarding knowledge about and adoption of innovations released by the Juma Experimental Station is recorded in the second section of the questionnaire. Information pertaining to the explanatory variables was written in the last part (see Appendix). A pretest (described in the field study section of this chapter) was carried out to ensure the accuracy and utility of each question in the interview procedure.

B. Sampling Procedure

In Chapter III, Part A described the study scope and the sample drawn from the 6,723 rice producers receiving credit from the public bank. Although these producers are not an exact representation of all the farmers growing this cereal in the country, several reasons were given above to justify the selection of this study population.

The formula used to estimate the sample size was the following (Cochran, 1963:54).

$$n = \frac{\dfrac{t^2PQ}{d^2}}{1 + \left[\dfrac{1}{N}\left(\dfrac{t^2PQ}{d^2} - 1\right)\right]} = \frac{\dfrac{(1.96)^2(32x68)}{5^2}}{1 + \left[\dfrac{1}{6,723}\left(\dfrac{(1.96)^2(32x68)}{5^2} - 1\right)\right]} = 318$$

where:

n is the sample size;

t^2 is the confidence level;

P is the percentage of rice producers who have adopted the released innovations;

Q is the percentage of rice producers who have not adopted the released innovations;

d^2 is the margin of error; and

N is the total number of rice growers working on government land.

Since there are some agricultural regions in the country with relatively few cases, the sample was increased by 50 percent (159 cases) to insure that regions with fewer cases were well represented. In addition, because in the implementation of any survey there are people who are difficult to find and interview, the sample was increased by another 25 percent (119 cases). So, the final sample consisted of 597 cases but actually the study only needed 478 cases because the last increase was made to have replacement cases.

Since sampling procedure requires that the cases in the population have the same chance of selection, a table of random numbers was used to select the sample (Arkin and Colton, 1963). Table 6 shows the distribution of sample sites and number of cases selected by rice regions in the Dominican Republic.

C. Field Study

The field work started with a two-day pre-test carried out among eighteen rice producers in the last week of November, 1978. Applicability of the questions was the main concern of this test. After this phase, and taking into consideration the experience obtained, the questionnaire

TABLE 6

DISTRIBUTION OF PROJECTS AND PERSONS IN THE SAMPLE BY REGION

REGION	NUMBER
NORTH REGION:	
Projects in the sample	18
Persons in the sample	67
CENTRAL CIBAO:	
Projects in the sample	53
Persons in the sample	450
SOUTH REGION:	
Projects in the sample	1
Persons in the sample	3
EAST REGION:	
Projects in the sample	5
Persons in the sample	77
Total number of projects in the sample	77*
Total number of persons in the sample	597

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*The number of projects in the sample is smaller than in Table 2 because Table 2 refers to projects with available information only, not to projects in the sample.

was modified. The most significant change produced by the pre-test was to eliminate questions pertaining to the physical, chemical, and climatological characteristics. The pre-test showed that information on such factors as rainfall, temperature, drainage, and soil pH was difficult to obtain from the farmers themselves. Therefore, all of these problem variables were dropped from the study.

After the pre-test, eleven technicians, assigned from the Secretariat of Agriculture to assist with the field data collection phase, were trained to administer the questionnaire. Consistent interpretation of the questions and standardization of interview techniques were the goals of this training. All interviewers had previous experience in this type of work. Application of the final questionnaire started on December 7, 1978, and terminated on January 9, 1979.

The approach used to reach and identify the 597 rice producers was as follows: the interviewer (as a group or individually) went to the local project office. Then the local field representative of the Dominican Agrarian Institute helped the interviewer find the sample of that project's rice producers. The interview then took place. The application of the questionnaire could be carried out in the farmer's home or farm, the Dominican Agrarian Institute office, a neighbor's house, or in any other convenient place.

In some cases, a listed farmer was changed for another. This took place when the farm of the first choice had been passed on to another producer so that the interviewed farmer was the current owner of the parcel which was originally listed under another owner. Also, if the farm owner was not directly working the land, the person who did so was interviewed.

The total number interviewed was 437. This represents 91.4 percent of the needed sample number (478 cases). The reasons for which the original number of cases was only partially reached are: a) due to changes in farm ownership, b) farmer's absence at the time of the interviewer's visit, c) difficulties in physically locating the farmer. After the end of the field study, interviewed farmers were classified into two categories: producers with the seedbed system and producers with the direct seed system. There were 326 in the first group and 111 in the second. Analyses of the data were made according to these two categories.

D. Data Processing and Reduction

The methodology of this dissertation can be synthesized into seven steps (see Table 7). The first step was that of defining the variables. Both the explanatory and problem variables were defined operationally following theoretical results and empirical findings (in the case of the explanatory variables) and the criteria of the technicians working at the Juma Experimental Station (in the case of the problem variables). The second step involved the field study. In this step, the study's data were collected using a questionnaire as the interview procedure. The third step was the reduction and transformation of the variables. The problem variables

TABLE 7

ILLUSTRATION OF STUDY METHODOLOGY

Step No.	Activity	Variables or Intervening Factors	Results
1	Definition of Variables	Explanatory and problem variables	Operational definitions
2	Field Study	Explanatory and problem variables	Data for the study
3	Reduction and transformation	50 problem variables for SBS* and 37 problem variables for DSS**	Two problem variables: the adoption score and degree of knowledge about innovations
4	Correlatinn analysis	51 explanatory variables with the adoption score and degree of knowledge about innovations	204 correlations: 102 for each type of producers or 51 for the adoption score and 51 for the degree of knowledge about innovations
5	Factor analysis	51 explanatory variables were grouped into factors	9 factor scores for SBS* and 10 factor scores for DSS**
6	Multiple regression equations	9 factors for SBS* with the adoption score and the degree of knowledge about innovations, and 10 factors for DSS** with the adoption score and degree of knowledge about innovations	Ranking of 9 factors according to their power to explain the variation in the adoption score and the degree of knowledge about innovations; ranking of 10 factors according to their power to explain the variation in the adoption score and the degree of knowledge about innovations
7	Findings analysis	All variables and factors	Hypotheses accepted and rejected, meaning of each factor, and testing of study's model

*SBS: Seedbed System
**DSS: Direct Seed System

(50 for producers with the seedbed system and 37 for producers with direct seed sytem) were summarized to become the adoption score and the degree of knowledge about innovations. Correlation analysis was the fourth step. In this step, the 51 explanatory variables were correlated with the two problem variables (the adoption score and degree of knowledge about innovations) by categories of farmers as a way to test both the two general and the twenty five specific hypotheses stated in Chapter III. The fifth step involved a factor analysis. This statistical technique was used to reduce the 51 explanatory variables into smaller number of elements (factor scores) which were the input data (explanatory variables) used during the multiple regression equations. The final analytical technique utilized and the sixth step was the generation of multiple regression equations. In this step, both the explanatory variables (factor scores) and the problem variables (the adoption score and the degree of knowledge about innovations) were used as input data to calculate four multiple regression equations. The equations ranked the explanatory variables according to their explanatory power upon the variance of the problem variables. The final step was the analysis of the findings. This step represented the acceptance or rejection of the hypotheses, the meaningful description of all the factors representing the explanatory variables, and finally, the analysis of whether or not the stated model was to be supported or rejected. Step number seven is described in Chapters V and VI, but several of the other steps are presented in this chapter. In the next paragraphs, the correlation,

factor and regression analysis are discussed in with more detail.

Part of the processing and reduction of the data for this research was done using the "Statistical Package for the Social Sciences" (SPSS) (Nie, Hull et al., 1975) and AMDAHL/450 V6-2. The work was done at the Northeast Regional Data Center of the State University System of Florida, located in Gainesville.

1. Correlation Analysis

Because it is difficult to deal with ordinal and nominal scales in correlation analysis, the nominal scale for the problem variables was changed to an ordinal scale. The change was made in the following manner: all negative answers in the second part of the questionnaire concerning problem variables were counted by each single producer; then, the new value was used as the representation of the adoption score and degree of knowledge about innovations by the producer. With this system (in relation to the problem variables), each farmer's score ranged from 1 to 50 if he was working with the seedbed system; and between 1 and 37 if he was working with the direct seed system. For instance, when a farmer has a value of 10 points in this kind of variable, that means he is using 40 (if seedbed system) of the 50 innovations he can potentially use. The explanatory variables did not need transformation in this stage of the research because they were recorded in an ordinal scale (from one to five) in the field study. With this change in the problem variables, the data are now in two ordinal scales: the explanatory variables with values from 1 to 5 and the problem variables with values from 1 to 50 (if seedbed system) or 1 to 37 (if direct seed system).

Since the study variables were in ordinal scales, the relationships among the problem and explanatory variables were tested using a non-parametric correlation technique. Spearman's rank-coefficient, ρ , was the technique used (Agresti and Agresti, 1979:238). This coefficient ranges between ± 1.0 where 1.0 means perfect positive correlation and -1.0 means perfect negative correlation; 0.0 indicates no correlation between the variables (Agresti and Agresti, 1979:336; Taylor, 1977:186).

Because the researcher needs to know whether interrelationships existed between the explanatory and the problem variables, and since the determination of the sign of the relationship was necessary, a one-tailed test was made. The null hypothesis (that there is no linear correlation between the explanatory and problem variables) was rejected when the value of alpha (α) was greater than 0.05 and accepted when alpha (α) was less than 0.05 (Mendelhall, Ott and Larson, 1974:414).

Since the correlation analyses were used to determine the relationships among the 51 explanatory variables, the correlation between each one of the 51 explanatory variables and the adoption score and degree of knowledge about new technology were established. Because the farmers are grouped into two categories, 102 correlations were calculated for producers using the seedbed system and 102 correlations for producers using the direct seed system. In each type of producers, 51 correlations belonged to the adoption score and 51 to the degree of knowledge about innovations (see Table 7, Step 4).

2. Factor Analysis Program

The goals of this step in the data processing and reduction work were two: to reduce the number of explanatory variables for the multiple regression equations and to be sure that the group of explanatory variables is independent with respect to the others. To achieve these goals, the principal component analysis with orthogonal rotation (varimax option) was used. The advantage of this solution is that each factor is characterized by a contribution of the variables with very large loading in a single factor, thus, the factors tend to have loading near to 1's or 0's (Yeates, 1974:234; Nie, Hull et al., 1975:482). In this work and attending to the following reasons: a) the use of 0.7 as a cut-off point to include the variables into the factors; and b) to save the bigger number of variables in each factor; a general rounding procedure (Mendelhall, Ott and Larson, 1974:33-34) was used to take into consideration only variables with loading greater than 0.65 in each factor. So, all the variables with loading smaller than 0.65 were not taken into account. If a factor had only one variable and this variable had a loading less than 0.65, the factor was not used in the multiple regression equations.

The factor analysis program was used only for the 51 explanatory variables. In this sense and in the case of the producers with the seedbed system, the 51 explanatory variables were grouped into 12 factors. Since only variables with loading greater than 0.65 were considered, three factors, which had only one variable and the variables had loadings smaller than 0.65, did not qualify for the multiple regression equations. The 51 explanatory variables for producers with the direct seed system were grouped into 10 factors. In this case, all but one factor went into the multiple regression equations.

3. Regression Analysis Program

The goal of this step was to evaluate the contribution of each one of the explanatory variables (factor scores) explaining the variation in the problem variables (the adoption score and the degree of knowledge about innovations). Since the multiple regression equation requires that the variables be measured on an interval or ratio scales, the values of the problem variables used in the correlation analysis were transformed into percentages. These percentages and the factor scores from the explanatory variables were the data used in the four multiple regression equations.

The "forward (stepwise) inclusion" was the option used to achieve the goal of this phase of analysis. This option means that the explanatory variables "... are entered only if they meet certain statistical criteria. The order of inclusion is determined by the respective contribution of each variable to explain variance" (Nie, Hull et al., 1975: 345). For instance, multiple regression correlation coefficient, R, and the multiple coefficient of determination, R^2, were used to analyze the strength of the relation between the factor scores (explanatory variables) and the problem variables (the adoption score and the degree of knowledge about innovations).

From the four multiple regression equations calculated, two equations referred to producers with the seedbed system and the other two analyzed data that referred to producers with the direct seed system. All the equations relate the factor scores to the adoption score and degree of knowledge about innovations in each type of producer.

Only when the contribution of a factor was more than one percent in the explanation of the variation in the problem variables, was it taken into consideration during the regression analysis section in the following chapter which describes analysis of the findings.

E. Study's Limitations

All research undertaken has some kind of limitation and this fact is well known and accepted. This study, like any other, has its shortcomings, the more important of which are listed below:

1. Information was available for only 66.1 percent (6,723 cases) of the total 10,168 rice producers farming public land in the Dominican Republic. As a result, the

the actual study's population was smaller by 37.9 percent than the total number of rice growers working under public land. A total number of 478 cases was used as the study's sample.

2. A subjective, not an objective approach, was used to measure the explanatory variables. For instance, all questions were posed in such a way that farmers answered according to their perception of the situation.

3. In carrying out the structure field interview, three factors emerged which could affect the study's findings. First, 26 cases (5.4 percent) of the sample population were not located due to changes in farm ownership, farmer's absence at the time of interviewer's visit, or difficulties in physically locating the farm. Second, 15 cases (3.1 percent of the sample) were removed since the interview was not completed. Third, in cases where the farmers did not answer the questions concerning the explanatory variables, a value of three (midpoint in the scale) was assigned.

4. Considering the fact that the research reported herein describes one of the first studies concerning the diffusion of technological innovation in rice cultivation in the Dominican Republic; and taking into consideration, too, that very little reference material already exist at the national level, the results of the dissertation, at best, should be considered an initial attempt to explain

the underlying cause-effect relationship affecting modernization of small-holder agricultural systems in the Dominican Republic.

5. That the dissertation's conclusions are validated mainly by rice producers working under public land and who are using public credit in the production process.

This chapter presented research methodology as a way to explain the different procedures used to analyze the study's data. The writer also hoped that the above discussion may be useful in arriving at a better understanding of the results' analysis as described in the next chapter, Chapter V.

CHAPTER V
RESULTS OF THE INVESTIGATION

Chapter IV presented the statistical techniques and the integrated methodology used to analyze the findings of this investigation. Now, Chapter V presents a detailed picture of the obtained results. This part begins with correlation analysis in which the correlations and alpha values were used to accept or reject the stated hypotheses. After the transcription and testing of each hypothesis, a brief comment was made to explain the meaning of the analysis. Part B of this chapter, factor analysis, presented an explanation of each of the factors representing the explanatory variables which belonged to the two categories of rice producers (seedbed system and direct seedbed system). Part C, regression analysis, was used to determine which were the factors with stronger explanatory power concerning the variance of the adoption score and the degree of knowledge about the innovations by categories of producers.

A. Correlation Analysis

Correlation analysis of the explanatory and problem variables was conducted at two levels. First, a general analysis was made of the number of hypotheses accepted and rejected by categories of producers and for the adoption score and degree of knowledge about the innovations. Second, an analysis was made following a hypothesis by hypothesis approach. Kind of producers and type of problem variables also were taken into consideration at the second analytical level.

In all cases, the relationship was accepted when the test of significance showed that α was $= .05$; $\alpha = .01$ was also indicated when it occurred but only at the second level of analysis. In both cases, the degrees of freedom (df) were constant by category of farmer: producers with seedbed system were referred to in 326 cases and producers with direct seed system were referred to in 111 cases. Since these results have a relatively large sample size, small correlation values may be statistically significant. A last point to be made is that some hypotheses are related to more than a single explanatory variable and that the problem variables are related to the adoption score and degree of knowledge about new technology.

All 51 explanatory variables were considered in the general analysis of the hypotheses and were used as a foundation to test the two general hypotheses. This first approach indicates that 42 explanatory variables showed correlation with the ability for adoption among the farmers with seedbed system. From these 42 tested relationships, 39 had a positive correlation and 3 had a negative correlation. Nine explanatory variables were not correlated at a statistically significant level with the adoption ability of this type of farmer.

The correlation with the highest score (r=.44) was between the trialability of the new technology and the adoption ability of the producer (see Table 3), while the smallest correlation (r=.11) occurred for four explanatory variables and the adoption ability of the producers. Two of these correlations had a positive sign and two had a negative sign (see Table 8).

The correlations among the explanatory variables and degree of knowledge about innovation for producers using the seedbed system present the following picture: 38 explanatory variables had correlation, all with a positive sign; while 13 explanatory variables were not significantly correlated. In the former case, two explanatory variables had the highest correlation (r=.43): trialability of new technology and rationality of farmer. The explanatory variables with smallest correlation (r=.12) were storage facilities' location and homophyle between change agent and farmers.

The findings showed that there are 34 explanatory variables with positive and significant correlation for producers on the direct seed system in relation to score of adoption. Seventeen explanatory variables were not correlated at a statistically significant level. Rationality of the farmer and score of adoption had the highest correlation (r=.50). Change agent status among the farmers and the adoption score had the smallest significant correlation (r=.16).

Relationships between explanatory variables and degree of knowledge among producers with direct seed system were

TABLE 8

DEGREE OF CORRELATION AND LEVELS OF SIGNIFICANCE BETWEEN EXPLANATORY AND PROBLEM VARIABLES BY CATEGORIES OF RICE PRODUCERS

Name of explanatory variables	Farmers with Seedbed System				Farmers with Direct Seed System			
	Score of Adoption		Degree of knowledge about the innovation		Score of Adoption		Degree of knowledge about the innovation	
	r	α	r	α	r	α	r	α
1. Profitability	.29	.01	.31	.01	.30	.01	.26	.01
2. Compatibility	-.13	.01	-	-	-	-	-	-
3. Trialability	.44	.01	.43	.01	.22	.01	-	-
4. Complexity	.37	.01	.38	.01	.42	.01	.33	.01
5. Observability	.33	.01	.33	.01	.19	.05	-	-
6. Change agent's (CA) location	.36	.01	.36	.01	.39	.01	.38	.01
7. Demonstration plot location	.11	.01	.13	.01	.24	.01	.26	.01
8. Credit services' location	.12	.01	.13	.01	.35	.01	.36	.01
9. Inputs (fertilizers and pesticides) location	.24	.01	.23	.01	.42	.01	.36	.01
10. Storage location	.16	.01	.12	.01	.30	.01	.27	.01
11. Buyers' location	.17	.01	.16	.01	-	-	-	-
12. Farmer age	-	-	-	-	-	-	-	-
13. Farmer dependents	-.11	.05	-	-	-	-	-	-
14. Farm size	.22	.01	.19	.01	-	-	-	-
15. Farmer's educational level	.09	.05	-	-	-	-	-	-
16. Farmer's social status	.32	.01	.30	.01	-	-	-	-
17. Intensity of cultivation	.28	.01	.29	.01	.17	.05	.21	.01
18. Economic capacity of farmer	-	-	-	-	-	-	.19	.05
19. Farm specialization	-	-	-	-	-	-	-	-
20. Empathy	.20	.01	.24	.01	.29	.01	.33	.01
21. Dogmatism	.11	.05	.13	.01	.29	.01	.20	.01
22. Rationality	.39	.01	.43	.01	.50	.01	.50	.01
23. Attitude toward change	.19	.01	.20	.01	-	-	-	-
24. Attitude toward risk	-	-	-	-	-	-	-	-
25. Attitude toward credit	-	-	-	-	-	-	-	-
26. Attitude toward science and technology	-	-	-	-	.28	.01	.24	.01
27. Level of aspiration	-	-	-	-	.24	.01	.21	.01
28. Social participation of farmer	-	-	-	-	-	-	.07	.05
29. Farmer local integration	.20	.01	.20	.01	-	-	.17	.05
30. Farmer cosmopolitan attitude	-.11	.05	-	-	-	-	-	-
31. Meeting of farmer with CA	.30	.01	.23	.01	.40	.01	.35	.01
32. Mass media exposure of farmer	.33	.01	.38	.01	.24	.01	.27	.01
33. Farmer interpersonal communication channels exposure	.25	.01	.31	.01	.30	.01	.23	.01
34. Degree of opinion leadership	.11	.05	.16	.01	.29	.01	.29	.01
35. CA effort	.33	.01	.23	.01	.42	.01	.37	.01
36. CA knowledge	.30	.01	.20	.01	.24	.01	.20	.01
37. CA orientation: client/agency	.16	.05	.14	.01	.21	.01	.22	.01
38. CA hemophyle with farmers	.15	.01	.12	.05	.22	.01	.19	.05
39. CA empathy with farmers	.15	.01	-	-	-	-	-	-
40. CA social status among clients	.23	.01	.18	.01	.16	.05	-	-
41. CA social participation with clients	.34	.01	.26	.01	.27	.01	.22	.01
42. CA relation with opinion leaders	.29	.01	.20	.01	.19	.05	-	-
43. CA credibility among farmers	.37	.01	.29	.01	.35	.01	.31	.01
44. Credit services	.26	.01	.27	.01	.48	.01	.38	.01
45. Seed's services	.29	.01	.29	.01	.28	.01	.28	.05
46. Fertilizers, pesticides, herbicides, raticides, machinery, irrigation/drainage services	.33	.01	.39	.01	.43	.01	.38	.01
47. Labor services	.26	.01	.27	.01	.21	.01	.24	.01
48. Harvest, transportation, drying, and storage services	.33	.01	.37	.01	.27	.01	.23	.01
49. Benefit/cost relationship	.22	.01	.24	.01	-	-	-	-
50. Mass media channels	.29	.01	.39	.01	.21	.01	.23	.01
51. Interpersonal channels	.15	.01	.19	.01	.40	.01	.38	.01

positive and significant in 33 cases, while 18 explanatory variables were not significantly correlated. Rationality of producers and ability of the farmer to know about the new technology had the highest correlation (r=.50). Social participation of farmers had the smallest significant correlation (r=.07) with the same problem variable.

Although when testing producers with the direct seed system, 18 explanatory variables were not correlated with the degree of knowledge about the new technology when an analysis is made by group of explanatory variables. Table 8 shows that variables with positive and significant correlations surpass the number of variables without correlations. The findings seem to support the statement of the first general hypothesis: "The attributes of the innovations, locational factors, farmers' characteristics, change agent's characteristics, the amount, quality and quantity of the services and inputs offered to the farmers and diffusion process channels are all relevant elements which are associated with the degree of knowledge about and/or adoption of new varieties and/or products."

The first part of the general hypothesis was also confirmed as explanatory variables showed different levels of association with the degree of knowledge about and adoption of new technology. The latter part of the second general hypothesis was analyzed and it is reported in the subsequent section describing results of the regression analysis.

Since the specific hypothesis was stated so that more than one explanatory variable was linked to the score of adoption and degree of knowledge about the innovations, the level of support for these hypotheses are not always related to all the explanatory variables in the hypotheses. For example, if a hypothesis has six explanatory variables, but only four had significant correlations with the analyzed problem variable, the confirmation of that hypothesis is noted as 4/6.

The first specific hypothesis tested was that "the relative advantage of a new variety, practice, or product, as perceived by the farmer, is positively related to the degree of knowledge and adoption." This hypothesis was confirmed, for farmers using the seedbed system, relative to scores of adoption, with a correlation of $r=.29$, $\alpha=.01$. The same hypothesis and for the same type of farmers, but in relation to degree of knowledge about new technology, also was accepted ($r=.31$, $\alpha=.01$). In the case of producers with direct seed system and score of adoption, this hypothesis also was supported ($r=.30$, $\alpha=.01$). The degree of knowledge about new technology and the profitability of the innovations furthermore have positive and significant correlation for producers using the direct seed system ($r=.26$, $\alpha=.01$). These results mean that when an innovation is more profitable than the old technology, it is more likely that both categories of producers will know about and adopt the innovation.

Hypothesis two states that "the compatibility of a new variety, practice, or product with current values, beliefs. practices, and products, as perceived by the farmer, is positively related to the degree of adoption and knowledge." This hypothesis was accepted only for the adoption score of farmers using the seedbed system ($r=.13$, $\alpha=.01$). It presents a negative relationship which is opposite to the sign hypothesized. According to these results, when an innovation is strongly similar to the farmer's values, beliefs, practices, and products, it will still be unlikely that he will accept the recommendation. This hypothesis was rejected in relation to degree of knowledge about innovations for both types of farmers and for farmers using the direct seed system in relation to the adoption score. The results of this correlation are infrequent for most of the empirical investigations because the similarity between an innovation and a farmer's values, beliefs, practices, and products is a useful element which improves the knowledge and adoption functions. A reason to explain this unexpected outcome could be that the question about this variable was not clear enough to the producers, so they did not understand the question.

The third hypothesis states that "the triability of a new variety, practice, or product as perceived by the farmer is positively related to the degree of knowledge and adoption." This hypothesis was confirmed for farmers using the seedbed system for both problem variables ($r=.44$, $\alpha=.01$ and $r=.43$, $\alpha=.01$, respectively). A positive correlation between triability and score of adoption also was supported for farmers using the direct seed system (r=.22, α=.01). This hypothesis was rejected for farmers using the direct seed system, in relation to the degree of knowledge about innovations, a new technology with easier test and application conditions has a higher level of knowledge and degree of adoption among those producers.

Hypothesis four states that "the complexity of a new variety, practice or product as perceived by the farmers is negatively related to the degree of knowledge and adoption." This kind of relationship was accepted for both types of farmers and for the adoption score and degree of knowledge about the new technology. The complexity of the new technology showed positive and significant correlation with the adoption score and degree of knowledge about the innovations for both kinds of farmers. The correlations for adoption score and degree of knowledge about the innovation were r=.37, α=0.10 and r=.38, α=.01, respectively for farmers using the seedbed system. For farmers using the direct seed system, it was r=.42, α=.01 in the first case, and r=.33, α=.01 in the second case. This indicates that when a new technology is easier to understand and apply, it is more likely that producers will know about and use the innovation.

Hypothesis five says that "the observability of a new variety, practice or product as perceived by the farmers is positively related to the degree of knowledge and adoption by farmers". This hypothesis was tested for three of the problem variables. The observability of the innovations' results had a positive correlation with the degree of knowledge about ($r=.33$, $\alpha=.01$) and score of adoption ($r=.33$, $\alpha=.01$) for producers using the seedbed system. It also showed the same tendency with score of adoption ($r=.19$, $\alpha=.05$) for farmers using the direct seed system. These results indicate that if the product of a new technology is more visible than the product of the old one, the innovation can be accepted more easily.

Hypothesis six states that "the location of the change agent relative to the farm is positively related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." Table 8 shows that the location of a change agent had a positive and significant relationship with the adoption score and the degree of knowledge about the innovations for both farmers using the seedbed system ($r=.36$, $\alpha=.01$ and $r=.35$, $\alpha=.01$, respectively) and farmers using the direct seed system ($r=.39$, $\alpha=.01$ and $r=.39$, $\alpha=.01$, respectively). Interpretation of these results shows that producers are more likely to know about and to adopt a technological diffusion when the change agent is closer to the farm location.

The seventh hypothesis is that "the location of the research center and demonstration plot, relative to the farm, is positively related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." These relationships between the location of the demonstration plots and the four problem variables were positive and significant. Producers using the seedbed system registered r=.11, α=.05 relative to the adoption score and r=.13, α=.01 relative to degree of knowledge about the new technology. Producers using the direct seed system showed a correlation of r=.24, α=.01 in terms of score of adoption and r=.26, α=.01 with respect to the degree of knowledge about the innovation. According to this outcome, the closer to the farms are the demonstration plots, the higher the probability of knowing about and adopting the released technology.

Hypothesis eight states that "the location of services and inputs, relative to a farm, is positively related to the degree of knowledge about and adoption of a new variety, practice or product by farmers". The hypothesized interrelation between the location of credit and other input services and the problem variable was accepted for the four cases. Acceptance means that location of the credit office and supplies (seeds, fertilizers, rodenticides, herbicides, machinery and labor) is a critical factor in the spread and adoption of new agricultural technology. The degree of correlation tested in this hypothesis can be seen in Table 9.

Hypothesis nine is that "the location of drying and storage facilities and buyers relative to the farm is positively related to the degree of knowledge about and adoption of a new variety, practice or product by farmers" This hypothesis was supported for producers using the seedbed system in both explanatory variables, but this relationship

TABLE 9

DEGREE OF CONFIRMATION OF HYPOTHESES BY CATEGORIES OF PRODUCERS, ADOPTION OF SCORE AND DEGREE OF KNOWLEDGE ABOUT THE INNOVATIONS

Hypotheses	Producers using the Seedbed System		Producers using the Direct Seed System	
	Adoption of Score	Degree of knowledge about the innovation	Adoptinn of Score	Degree of knowledge about the innovation
1	1	1	1	1
2	1	1	0/1	0/1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	0/1
6	1	1	1	1
7	1	1	1	1
8	2/2	2/2	2/2	2/2
9	2/2	2/2	1/2	1/2
10	2/3	1/3	0/3	0/3
11	3/4	3/4	1/4	2/4
12	4/8	4/8	5/8	5/8
13	6/7	5/7	4/7	6/7
14	1	1	1	1
15	1	1	1	1
16	2/2	2/2	2/2	2/2
17	1	0/1	0/1	0/1
18	2/2	2/2	2/2	1/2
19	1/1	1/1	1/1	0/1
20	1	1	1	1
21	1	1	1	1
22	3/3	3/3	3/3	3/3
23	1	1	1	1
24	1	1	0/1	0/1
25	0/0	0/1	1	0/1

was tested only in one explanatory variable for producers using the direct seed system (see Table 9). These results mean that the location of drying, storage and buying facilities are important to the knowledge and the adoption function, at least for farmers using the seedbed system.

The tenth hypothesis states that "farmers with a higher degree of knowledge about and adoption of a new variety, practice or product tend to be younger, more educated and of higher social status than farmers with a lower degree of knowledge about and adoption of the innovation." The verification of the relationship defined between the explanatory and problem variable was varied for farmers using the direct seed system. There was no correlation in the case of farmers using the direct seed system. When producers using the seedbed system were analyzed, two of the three explanatory variables were correlated with score of adoption. Only one of the three explanatory variables was correlated with the degree of knowledge about the new technology (see Table 9).

Hypothesis eleven says that "farmers with a higher degree of knowledge about and adoption of a new variety, practice or product have farms of medium size (about 3.5 has.), have a commercial rather than subsistence orientation, have greater opportunity to acquire credit from the institutional system, and have farms with rice alone and with a single variety of rice." This hypothesis was only partially supported by both types of rice farmers. The relationships among farm size, intensity of cultivation, economic capacity of farmers and farm specialization, and the adoption score and degree of knowledge about the new technology were confirmed in two of four variables for producers using the direct seed system in the following way: the adoption score two of four; degree of knowledge about released innovations two of four (see Table 9).

Hypothesis twelve states that "farmers with a higher degree of knowledge about and adoption of a new variety, practice or product tend to have more empathy with the change agent and other farmers, less dogmatic attitudes, more rational approaches to decision-making, more openness to change, risk, and technical and scientific knowledge, a higher level of aspiration in relation to education, occupation, and income than do the farmers with a lesser degree of knowledge about and adoption of innovation." The hypothesized relationship was partially confirmed for both kinds of farmers. It was supported in four of eight cases for producers with the seedbed system relative to score of adoption and degree of knowledge about the new technology, respectively. It was significant also in five out of eight cases for farmers using the direct seed system relative to both problem variables.

The thirteenth hypothesis says that "farmers with a higher degree of knowledge about and adoption of a new variety, practice or product tend to participate more socially, be more integrated into the social system, have more cosmopolitan attitudes, have more contacts with the change agent, experience more exposure to media and interpersonal communication channels, and express a higher degree of opinion leadership than farmers with a lesser degree of knowledge about and adoption of innovation" These interrelationships among the farmer's social participation, local integration, cosmopolitan attitude, meeting with change agent, mass media exposure and interpersonal communication channels and the problem variables were partially supported by the findings. Those data about producers using the seedbed system showed that score of adoption and degree of knowledge about the innovations were confirmed in six out of seven and five out of seven cases, respectively. The same correlations were supported in four out of seven and six out of seven cases, respectively, for farmers using the direct seed system. For one explanatory variable, farmer's cosmopolitan attitude relative to score of adoption for farmers using the seedbed system, the correlation had a negative sign (see Table 8).

Hypothesis fourteen is "the degree of change agent effort in terms of contacts with farmers, is positively related to the degree of knowledge about and adoption of the innovation by farmers." A positive and significant relationship was observed between the degree of change agent effort and the adoption score and the degree of knowledge about the recommended technology for both kinds of rice producers. The farmers with the seedbed system showed: score of adoption, r=.23, α=.01; and the degree of knowledge about the innovation, r=.42, α=.01 and r=.37, α=.01, respectively, for the same problem variables. These results indicate that while more contacts the change agent has with the farmers, the larger the probability to the farmers knowing about or adopting the new technology.

The fifteenth hypothesis states that "the degree of change agent knowledge about the new variety, practice or product are positively related to the degree of knowledge about and adoption of the innovation by farmers." This hypothesis was accepted in all cases. The interrelation of knowledge of the change agent and the adoption score and the degree of knowledge about the released technology were r=.30, α=.01 and r=.20, α=.01, respectively, for farmers using the seedbed system; in both problem variables for farmers using the direct seed system, it was r=.21, α=.01 and r=.22, α=.01. These data show that the better the change agent knows the new technology, the more likely it is that the farmer will know about and adopt the innovations.

Hypothesis sixteen states that "an orientation on the part of the change agent toward the farmer is positively related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." Although this hypothesis was stated with two explanatory variables, the relationship between them and the problem variables were accepted for both cases by both categories of farmers (see

Table 9). This outcome means that the similarity between the change agent and the farmer's "way of life" is an important factor to the adoption and knowledge functions.

Hypothesis seventeen states that "the change agent's empathy towards farmers' attitudes, beliefs, and behavior is positively related to the degree of knowledge about and adoption of a new practice, variety, or product by farmers." This hypothesis was accepted for producers with the seedbed system relative to score of adoption. The correlation between the problem variable and the adoption score was $r=.15$, $\alpha=.01$. According to those results, when the change agent shows a better identification with farmers' attitudes, beliefs, and conduct, the producers are more likely to know about and accept the recommended technology.

The eighteenth hypothesis states that "the degree of change agent's social status and the degree of social participation among farmers are positively related to the degree of knowledge about and adoption of a new variety, practice, or product by farmers." A positive and significant relationship was confirmed for all but one problem variable. The adoption score and the degree of knowledge about the new technology had a correlation as hypothesized in relation to producers using the seedbed system. The same relationship was observed only in one of the two variables for farmers using the direct seed system relative to degree of knowledge about the innovations (see Table 9). These results indicate that the higher prestige and interrelation the change agent has among the producers, the greater is the chance to spread the innovations among the rice growers.

Hypothesis nineteen states that "the degree of change agent work among community leaders is positively related to the degree of knowledge about and adoption of a new variety, practice, or product by farmers." This hypothesis was accepted in all cases except for farmers using the direct seed system relative to degree of knowledge about the new technology. The farmers using the seedbed system had the following correlation: the adoption score, $r=.37$, $\alpha=.01$; the degree of adoption of the innovations, $r=.29$, $\alpha=.01$. However, those farmers using the direct seed system had correlations of: $r=.35$, $\alpha=.01$ and $r=.31$, $\alpha=.01$, respectively, for the same problem variables. The consequences of these findings are that, except for the degree of knowledge about the innovations and in relation to farmers using the direct seed system, the more the change agent works among the rice growers, the greater is the probability of the producer knowing and accepting the innovations.

The twentieth hypothesis states that "the degree of change agent credibility is positively related to the degree of knowledge about and adoption of a new variety, practice, or product by farmers." This hypothesis was accepted by both types of farmers for the adoption score and the degree of knowledge about the released technology. The correlations for the adoption score and degree of knowledge about the innovation were $r=.37$, $\alpha=.01$ and $r=.29$, $\alpha=.01$, respectively, for farmers using the seedbed system. For farmers using the direct seed system, it was $r=.35$, $\alpha=.01$ in the first case and $r=.31$, $\alpha=.01$ in the second case. This indicates that when the change agent's credibility is high among the rice growers, there is a higher chance they will know about and adopt the innovations.

Hypothesis twenty-one states that "the amount, availability, and conditions of credit offered to farmers are related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." The relationship between credit services and the problem variables was positively associated for both types of farmers. Producers using the seedbed system had a correlation with the adoption score of $r=.26$, $\alpha=.01$ and with degree of knowledge of released technology of $r=.27$, $\alpha=.01$. The correlations for farmers using the direct seed system were $r=.48$, $\alpha=.01$ and $r=.38$, $\alpha=.01$, respectively, for the same problem variables. These findings mean that the better the credit services, the greater is the probability the farmers received the new technology.

Hypothesis twenty-two states that "the price, quality, quantity and availability of inputs are related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." The relationships between inputs, services and labor, and the problem variables were tested in all cases. All correlations were positive and significant for both producers using the seedbed system and producers using the direct seed system relative to score of adoption and the degree of knowledge about the innovations. According to those results, the producers are more likely to know about and adopt the released innovations if the inputs' services are better.

Hypothesis twenty-three is "transportation, drying and storage facilities are related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." The hypothesized interrelation between transportation and drying and storage services and the problem variables were supported by the data. The correlations for producers using the seedbed system were $r=.33$, $\alpha=.01$ for the adoption score and $r=.37$, $\alpha=.01$ for degree of knowledge about released technology. Correlations by farmers using the direct seed system were $r=.27$, $\alpha=.01$ and $r=.23$, $\alpha=.01$, respectively, for the two problem variables. These outcomes indicate that the marketing facilities are relevant factors in the knowledge and adoption functions of rice growers.

Hypothesis twenty-four states that "the profitability of rice production is related to the degree of knowledge about and adoption of a new variety, practice or product by farmers." According to Table 8, the relationship between the profitability of rice production and the adoption score and the knowledge about the new technology for farmers using the seedbed system for both problem variables was accepted. The adoption score was $r=.22$, $\alpha=.01$, and degree of knowledge about the innovation

$r=.24$, $\alpha=.01$. These findings mean that the innovation's profitability is an element more critical for farmers using the seedbed system than rice growers using the direct seed system.

The last specific hypothesis states "mass media channels are relatively more important in the knowledge function and interpersonal channels are relatively more important in the adoption functions of a new variety, practice or product." This hypothesis was confirmed in its first part for both kinds of rice producers. Correlations were greater for the degree of knowledge about released innovations than for the adoption score. Correlations for the scores of adoption were $r=.29$, $\alpha=.01$ and $r=.21$, $\alpha=.01$, while correlations for the degree of knowledge about the new technology were $r=.39$, $\alpha=.01$ and $r=.23$, $\alpha=.01$. The stated relationship between interpersonal channels and the problem variables was observed only by farmers using the direct seed system. The correlation between explanatory variables and score of adoption was $r=.40$, $\alpha=.01$ while the correlation between the same explanatory variable and the degree of knowledge about the new technology ($r=.38$, $\alpha=.01$) was slightly less. Those data for the farmers using the seedbed system showed an opposite relationship to that hypothesized since the adoption function had a smaller correlation than the knowledge function; $r=.15$, $\alpha=.01$ and $r=.19$, $\alpha=.01$, respectively. According to these results, it is inferred that in the first stage of the diffusion process, when the innovations began to be released, the mass media channels are better to create awareness about the new technology, but in a later stage, the interpersonal channels should be used to improve the adoption process.

B. Factor Analysis

The factor analysis program was run only for the explanatory variables. For this reason, there were two types of factors: factors about producers using the seedbed system and factors about producers using the direct seed system. The first category has nine factors (I, II, III, IV, V, VI, VIII, IX, and XI); the second category has ten (from I to X). Discussed first are the factors derived from producers using the seedbed system (see Table 10 and 11).

Factor I includes seven explanatory variables and they are: meeting of farmer with change agent; change agent effort; change agent knowledge; change agent social status among clients; change agent social participation with clients; change agent relations with opinion leaders; and change agent credibility among farmers. Since all variables in this factor belong to some aspect of the change agent, the name given to it is "Change Agent's Characteristics." This component represents all the concepts measured by each one of the variables included in it.

All three variables forming Factor II represent characteristics of the released innovations. They are: profitability of innovations; complexity of innovations; and observability of innovations. The name assigned to this component is "Innovations' Characteristics" and it summarizes the underlying concepts of the variables.

TABLE 10

FACTOR ANALYSIS OF EXPLANATORY VARIABLES FOR FARMERS USING THE SEEDBED SYSTEM

Derived Factors and Associated Variables		Loading of Variables
Factor 1:	Change Agent's Characteristics	
VAR030:	Meeting of farmer with change agent	.77019
VAR035:	Change agent effort	.84956
VAR036:	Change agent knowledge	.81414
VAR040:	Change agent social status among clients	.75014
VAR041:	Change agent social participation with clients	.86824
VAR042:	Change agent relation with opinion leaders	.74606
VAR043:	Change agent credibility among farmers	.80062
Factor II:	Innovations' Characteristics	
VAR001:	Profitability of innovation	.69462
VAR004:	Complexity of innovation	.79739
VAR005:	Observability of innovation	.65245
Factor III:	Farmer Interpersonal Communication	
VAR033:	Farmer interpersonal communication channels exposure	.66547
VAR034:	Degree of opinion leadership	.66459
VAR051:	Interpersonal channels	.70276
Factor IV:	Seed and Labor Services	
VAR045:	Seed Services	.65618
VAR047:	Labor Services	.66303
Factor V:	Location of Marketing Services	
VAR010:	Storage location	.76297
VAR011:	Buyers' location	.70820
Factor VI:	Compatibility Between Change Agent and Farmers	
VAR038:	Change agent homophyle with farmers	.80688
VAR039:	Change agent empathy with farmers	.80863
Factor VIII:	Inputs and Service Location	
VAR008:	Credit Services location	.79423
VAR009:	Inputs (fertilizers and pesticides) location	.71411
Factor IX:	Farmer Cosmopolitan Attitude	
VAR030:	Farmer Cosmopolitan Attitude	.69716
Factor XI:	Farmer Educational Level	
VAR015:	Farmer educational level	.74176

TABLE 11

FACTOR ANALYSIS OF EXPLANATORY VARIABLES FOR FARMERS USING THE DIRECT SEED SYSTEM

Derived Factors and Associated Variables		Loading of Variables
Factor I:	Change Agent's Characteristics	
VAR031:	Meeting of farmer with change agent	.68727
VAR035:	Change agent effort	.82778
VAR036:	Change agent knowledge	.78395
VAR041:	Change agent social participation with clients	.79182
VAR043:	Change agent credibility among farmers	.79185
Factor II:	Innovation and Economic Capacity	
VAR004:	Complexity of innovations	.66426
VAR018:	Economic capacity of farmer	-.72466
Factor III:	Observability of Innovation	
VAR005:	Observability of innovations	.89482
Factor IV:	Dogmatism of Farmer	
VAR021:	Dogmatism of farmer	.74797
Factor V:	Inputs and Service Location	
VAR006:	Change agent location	.69904
VAR008:	Credit services location	.81579
VAR009:	Inputs (fertilizers and pesticides) location	.68349
Factor VI:	Farmer's Characteristics	
VAR026:	Attitude toward science/technology	.66835
VAR027:	Level of aspirations	.80505
VAR028:	Social participation of farmer	.66460
Factor VII:	Farmer's Interpersonal Communication	
VAR033:	Farmer interpersonal communication channels exposure	.64641
VAR034:	Degree of opinion leadership	.77611
VAR051:	Interpersonal channels	.69020
Factor VIII:	Change Agent Homophyle with Farmers	
VAR038:	Change agent homophyle with farmers	.70004
Factor IX:	Seed Services	
VAR045:	Seed services	.65054
Factor X:	Intensity of Cultivation	
VAR017:	Intensity of cultivation	.87004

Factor III consists of three variables which refer to the communication ability of the producer. The variables are: farmer interpersonal communication channels exposure; degree of opinion leadership; and interpersonal channels. The name assigned to this component is "Farmer's Interpersonal Communication"

Factor IV has two variables: seed services and labor services. Although both variables are services, they are difficult to integrate into a single unit so the title for this component is "Seed and Labor Services"

Factor V, "Location of Marketing Services", is clearly a spatial factor. It has two variables both related to location: storage location, and buyers' location.

Change agent homophyle and empathy with farmers are closely related. Although homophyle is related to similarity relative to some attributes, and empathy means capacity to act with the same feelings and ideas, these variables tend to act together or facilitate the action of each other. Factor VI supports this view because it is formed by change agent homophyle with farmers and change agent empathy with farmers. This component was termed "Compatibility between Change Agent and Farmers."

Factor VIII, "Inputs and Service Location," represents credit services location and inputs location. Both variables measure mutually dependent inputs and services. As the location of these services is the concept measured, the name for this factor is "Inputs and Services Location".

Factor IX is the single variable, farmer cosmopolitan attitude, and its component keeps the name of the original variable. Factor XI is also a single variable. "Farmer's Educational Level" is the name for both factor and variable. Factors VII and X were not included in Table 10 because they did not have variables with loading bigger than 0.65.

There are ten factors for farmers using the direct seed system. The first represent five explanatory variables: meeting of farmer with change agent; change agent effort; change agent knowledge; change agent social participation with clients; and change agent credibility among farmers. Since all these variables are related to change agent's characteristics, it is called "Change Agent's Characteristics." This factor is virtually the same as in the case of producers using the seedbed system.

Factor II is the most complex and difficult component of both types of producers. It is formed by two variables which not only are dissimilar but have opposed signs. The variables are complexity of innovations and economic capacity of farmer (see Table 11). The name of this factor is "Innovation and Economic Capacity." Since this factor is formed by two variables with different signs, the signs of both variables have to be taken into consideration to do the interpretation of it.

Factor III is formed by a single variable, observability of innovation, and keeps the same name as the original variable.

The loading for this variable is the highest of all the explanatory variables for both categories of rice producers (see Tables 10 and 11).

Factor IV is composed also of a single variable: dogmatism of farmer and the name of the variable was assigned to the factor. Three variables related to the location of rice production inputs formed Factor V: change agent location; credit services location; and inputs location. Because these variables measure location of inputs' services, the name for this factor is "Inputs and Services Location". This component and Factor VIII, in the case of producers using the seedbed system, are very similar, the only difference being that the factor analyzed here includes change agent location.

Factor VI, "Farmer's Characteristics," represents two dimensions of farmers' thinking. Of the three variables of this component, two are related to farmer's attitude: attitude toward science and technology and level of aspirations. The other variable refers to the social participation of farmers.

Factor VII has three variables: they are farmer interpersonal communication channels exposure; degree of opinion leadership; and interpersonal channels. Since two out of these variables are related to communication channels and the other means interpersonal relation, the name for this factor is "Farmer Interpersonal Communication."

Factors VIII, IX, and X each contain a single variable. They are: change agent homophyle with farmers; seed services; and intensity of cultivation. These factors are named for their original variables.

C. Regression Analysis

Since this study is concerned with describing the direction and strength of the relationships among the explanatory and problem variables by category of producer, the analysis used the partial correlation coefficient, r, and the multiple coefficient of determination, R^2. The sign of the established relationship also was considered.

The multiple regression analysis began with factors related to producers using the seedbed system and used the score of adoption as the problem variable. The component entered first into the equation was Factor II, Innovations' Characteristics. The relationship between it and score of adoption was .31173, and it had a positive sign. According to the coefficient of determination of this equation, 9.7 percent of the variation in score of adoption is explained by this component. This single factor accounted for 32.4 percent of the total explanation given by the nine factors in the equation (see Table 12).

Factor I, Change Agent's Characteristics, went into the equation second. This component, with score of adoption, had a positive partial correlation with a coefficient of .20924. Table 12 shows that 8.1 percent of the variation in score of adoption is explained by the characteristics of the change agent.

Factor IX, Seed and Labor Services, placed third in the regression. Seed and Labor Services and score of adoption

TABLE 12

MULTIPLE REGRESSION RESULTS FOR PRODUCERS USING THE SEEDBED SYSTEM: FACTORS AND SCORE OF ADOPTION

Number and Name of Factor		Step No.	Partial r	R^2	Percentage given by each factor to the amount explained by all factors	Cummulative %
Factor II :	Innovations' Characteristics	1	.31173	9.7	32.4	32.4
Factor I :	Change Agent's Characteristics	2	.20924	8.1	27.1	59.3
Factor IV :	Seed and Labor Services	3	.28215	6.5	21.7	81.2
Factor III :	Farmer Interpersonal Communication	4	.16656	2.1	7.0	88.2
Factor V :	Location of Marketing's Services	5	.14053	1.5	5.0	93.5
Factor VI :	Compatibility between Change Agent and Farmer	6	.12416	1.1	3.8	97.0
Factor IX :	Farmer Cosmopolitan Attitude	7	-.07453	0.4	1.3	98.3
Factor VIII:	Inputs and Service Location	8	.06840	0.3	1.0	99.3
Factor XI :	Farmer Educational Level	9	.04409	0.1	0.3	99.6
	Total Variance explained			29.9		

showed a positive partial correlation of .28215. This component explained 6.5 percent of the variation in the problem variable.

Factor III, Farmer Interpersonal Communication was encountered in the fourth step of the equation. The relationship between this component and score of adoption was .16656 and it had a positive sign. Table 12 shows that 2.1 percent of the variation in the problem variable is explained by Factor III.

The correlation between Factor V, Location of Marketing Services, and score of adoption was found in step 5. It was positive with a coefficient of .14053. According to the output of the multiple regression equation, this factor explained 1.5 percent of the variation in score of adoption.

Factor VI, Compatibility between Change Agent and Farmers was keyed to the sixth step. This factor and the score of adoption had a positive partial correlation of .12416. The amount of variability of score of adoption explained 1.1 percent of the variance.

Factor IX, Farmer Cosmopolitan Attitude entered in seventh place in the stepwise equation. This component had a negative partial correlation with score of adoption and a coefficient of .07454. The proportion of variation given by this factor for the problem variable was 0.04 percent.

Factor VIII, Inputs and Service Location and Factor XI, Farmer Education Level, ranked eight and ninth in the equation, respectively. The positive partial correlations between these variables were .06840 and .04409, respectively. Factor VIII explained 0.3 percent of variation in score of adoption and Factor IX offered 0.1 percent of the explanation of variation.

Table 12 shows that 29.9 percent of the amount of variation in score of adoption can be explained by linear dependence upon these nine factors operating jointly. This result indicates that there are other explanatory variables not included in this multiple regression equation which explain the greater part of the variation in the adoption score.

The second multiple regression equation was run for producers using the seedbed system and degree of knowledge about the innovations. In this case, Factor II, Innovation's Characteristics, was the first component to be analyzed. Factor II and the problem variable had a positive correlation of .34747. It explained 12.1 percent of the variation in the problem variable. The proportion explained by this component represents 37.6 percent of the total explanation given by all factors in the equation (see Table 13).

Factor IV, Seed and Labor Services was analyzed in the second step of the program. The partial correlation between Seed and Labor Services and degree of knowledge about the released technology was .31176. The sign was positive. The explanation of variability given by this component of the problem variable was 8.5 percent.

Farmer Interpersonal Communication, Factor III, went into step three of the equation. It had a positive partial

TABLE 13

MULTIPLE REGRESSION RESULTS FOR PRODUCERS USING THE SEEDBED SYSTEM: FACTORS AND DEGREE OF KNOWLEDGE ABOUT THE INNOVATIONS

Number and Name of Factor		Step No.	Partial r	R^2	Percentage given by each factor to the amount explained by all factors	Cummulative %
Factor II :	Innovations' Characteristics	1	.34747	12.1	37.6	37.6
Factor IV :	Seed and Labor Services	2	.31176	8.5	26.4	64.0
Factor III :	Farmer Interpersonal Communication	3	.28604	6.5	20.2	84.2
Factor I :	Change Agent's Characteristics	4	.22056	3.5	10.9	95.1
Factor V :	Location of Marketing Services	5	.11384	0.9	3.0	98.1
Factor XI :	Farmer Educational Level	6	.06174	0.3	0.9	99.0
Factor VIII:	Inputs and Service Location	7	.05520	0.2	0.6	99.6
Factor VI :	Compatibility between Change Agent and farmer	8	.05125	0.2	0.6	100.2
Factor IX :	Farmer Cosmopolitan Attitude	9	-.01579	0.0	0.0	100.2
	Total Variance explained			32.2		

correlation with the problem variable with a value of .28604. The proportion of variation in the degree of knowledge about the innovations explained by Farmer Interpersonal Communication was 6.5 percent.

Factor I, Change Agent's Characteristics went into the fourth step of the regression program. Between this factor and degree of knowledge about new technology, there was a positive partial correlation which had a value of .22056. A variability of 3.5 percent was explained by Factor I. Table 13 shows that 95.1 percent of the total variation explained by all the factors in the equation is attributable to the first four components.

Factor V, Location of Marketing Services was run fifth. The correlation between this component and degree of knowledge about the released technology was .11384, with a positive sign. This factor contributed 0.9 percent to the variation related to the problem variable.

Factor XI, Farmer Educational Level went into the equation in step six. This component and degree of knowledge about the innovations had a positive partial correlation of .06174. The amount of explanation given to the variation of the problem variable was 0.3 percent.

Factor VIII, Inputs and Service Location and Factor VI, Compatibility between Change Agent and Farmers, were used in steps seven and eight, respectively. These components and the problem variable had a very small correlation coefficient. The explanation given by these factors to the variation of degree of knowledge about the new technology was 0.2 percent (see Table 13).

Farmer Cosmopolitan Attitude, Factor IX, was the last component to go into the equation. This factor and the problem variable had a negative and small partial correlation. No contribution was made by Factor IX to the explanation of variation related to the problem variables.

According to Table 13, 32.2 percent of the variation in the degree of knowledge about the released technology can be attributed to the nine factors into the equation. The findings show a low level of explanation. It appears that some important explanatory variables are missing from the equation.

The third multiple regression analysis was accomplished using ten factors as the explanatory variables and score of adoption as the problem variables (see Table 14). All these data are related to producers using the direct seed system. Inputs and Service Location, Factor V, was the first component to enter the equation. This factor and score of adoption had a positive correlation of .38211 and explains 14.6 percent (or 27.9 percent of the total variation explained by all the factors in the equation) of the variation belonging to score of adoption.

Factor IX, Seed Services, went into the second step of the program. This factor and the problem variation had a positive partial correlation of .38941. The amount of variation in the score of adoption that is explained by the Seed Services' factor is 13.0 percent.

TABLE 14

MULTIPLE REGRESSION RESULTS FOR PRODUCERS USING THE DIRECT SEED SYSTEM FACTORS AND SCORE OF ADOPTION

Number and Name of Factor		Step No.	Partial r	R^2	Percentage given by each factor to the amount explained by all factors	Cummulative %
Factor V :	Inputs and Service Location	1	.38211	14.6	27.9	27.9
Factor IX :	Seed Services	2	.38941	13.0	24.9	52.8
Factor I :	Change Agent's Characteristics	3	.32603	7.7	14.7	67.9
Factor VII :	Farmer Interpersonal Communication	4	.32067	6.7	12.8	80.3
Factor IV :	Dogmatism of Farmer	5	.24542	3.5	6.7	87.0
Factor VI :	Farmer's Characteristics	6	.22616	2.8	5.4	92.4
Factor X :	Intensity of Cultivation	7	.18929	1.9	3.6	96.0
Factor II :	Economic Capacity of Farmer	8	.13026	0.8	1.5	97.5
Factor VIII:	Change Agent Homophyle with Farmers	9	.11987	0.7	1.3	98.8
Factor III :	Observability of Innovation	10	.11991	0.7	1.3	100.1
	Total Variance explained			52.3		

Change Agent's Characteristics, Factor I, entered the equation at the third step. Score of adoption and this component had a positive partial correlation of .32603. Seven and seven tenths percent of the variation in the explanatory variable was attributed to this factor.

Factor VII, Farmer Interpersonal Communication, occupied the fourth step in the program. Between this component and the problem variable, there was a positive relationship with a coefficient of .32067. Score of adoption's variation explained by Farmer Interpersonal Communication was 6.7 percent.

Factor IV, Dogmatism of Farmer, went into step five of the equation. The correlation between the explanatory and the problem variable was positive with a coefficient of .34542. Three and five tenths percent of the amount of variation in score of adoption was explained by Dogmatism of Farmer.

Farmer's Characteristics, Factor VI, was used in the sixth step in the program. Between the component and the problem variable, there was a positive partial correlation which had a value of .22616. The proportion of explanation about the variation of the score of adoption attributed to this component was 2.8 percent.

Factor X, Intensity of Cultivation, occupied the seventh step in the equation. A positive partial correlation of .18929 was tested between this factor and the problem variable, which contributed 1.9 percent to the explanation of the variation of score of adoption. Steps one through seven, with the six factors accepted by the multiple regression equation, yielded 96.0 percent of the total variation given by all the factors in the program.

Economic Capacity of Farmer, Factor II, was placed in step number 8. The correlation between this component and the problem variable was positive with a coefficient of .13026. A percentage of 0.8 of the variation of score of adoption was explained by Factor II.

Both Factor VIII, Change Agent's Homophyle with Farmer, and Factor III, Observability of Innovations, and the problem variable had the same positive partial correlation (see Table 14). These components explained 0.7 percent of the variation of score of adoption.

The total amount of variation about score of adoption explained by these ten components operating jointly is 52.3, accounting for more than fifty percent of problem variable's variation. Thus, the results show that the main explanatory variables of the studied phenomena are contained in the equation.

The fourth and last multiple regression program was run with nine factors which represent the explanatory variables (see Table 15). Degree of knowledge about the released technology was the problem variable. The first component analyzed in the equation was Factor V, Inputs and Service Location. This component and the problem variable had a positive partial correlation of .38656. This factor

TABLE 15

MULTIPLE REGRESSION RESULTS FOR PRODUCERS USING THE DIRECT SEED SYSTEM: FACTORS AND DEGREE OF KNOWLEDGE ABOUT THE INNOVATIONS

Number and Name of Factor	Step No.	Partial r	R^2	Percentage given by each factor to the amount explained by all factors	Cummulative %
Factor V : Inputs and Service Location	1	.38658	14.9	29.6	29.6
Factor IX : Seed Services	2	.35419	10.7	21.2	50.8
Factor VII : Farmer Interpersonal Communication	3	.29283	6.4	12.7	63.5
Factor IV : Dogmatism of Farmer	4	.28381	5.5	10.9	74.4
Factor I : Change Agent's Characteristics	5	.28427	5.1	10.1	84.5
Factor VI : Farmer's Characteristics	6	.24931	3.6	7.1	91.6
Factor X : Intensity of Cultivation	7	.23332	2.9	5.8	97.4
Factor VIII: Change Agent Homophyle with Farmer	8	.13770	1.0	2.0	99.4
Factor III : Observability of Innovation	9	.08470	0.4	0.8	100.2
Total Variance explained			50.4		

explained 14.5 percent of the variation related to the degree of knowledge about released innovations, explaining 29.6 percent of the total explanation given by all factors included in the program.

Factor IX, Seed Services, was placed in the second step of the program. This component and degree of knowledge about the recommended technology had a positive partial correlation of .35419. The amount of problem variable's deviation explained by this component was 10.7 percent.

Farmer Interpersonal Communication, Factor VII, was accepted in the third step of the equation. Between this component and degree of knowledge about the new technology, there was a positive partial correlation with a value of .29283. Farmer Interpersonal Communication explained 6.4 percent of the variation in the problem variable.

Factor IV, Dogmatism of Farmer, went into the equation in the fourth place. This component and the problem variable had a positive partial correlation of .28381. Of the variation related to degree of knowledge about the released innovation explained by all the factors in the program, Factor IV contributed 5.5 percent.

Change Agent's Characteristics, Factor I, was placed in step 5 of the program. The explanatory and the problem variables had a positive partial correlation of .28427. This component explained 5.1 percent of the deviation related to the problem variable.

Factor VI, Farmer's Characteristics, went into the equation in step 6. This component and degree of knowledge about the innovations had a positive partial correlation of .24931. Farmer's Characteristics gave 4.6 percent of the explanation related to the variation of the problem variable.

Intensity of Cultivation, Factor X, occupied the seventh place in the stepwise regression. This factor and degree of knowledge about the new technology had a positive partial interrelation of .23332. The amount of explanation in the variation of the problem variable attributed to this component was 2.9 percent. These seven factors had explained 97.4 percent of the total variation explained by this equation.

Factor VIII, Change Agent's Homophyle with Farmers, was accepted in step eight. There was a positive relationship between this factor and the problem variable. This relation had a coefficient of .13770 and explained 1.0 percent of the variation related to the degree of knowledge about innovations.

Factor III, Observability of Innovation, was the last component to enter the equation. This factor and the problem variable had a positive partial correlation of .08470. The contribution of this component to the explanation of the variation in the problem variables was 0.4 percent.

Table 15 shows that the total amount of explanation given by the nine factors in the equation to the variation of degree of knowledge about the released technology was 50.4 percent. Other variables which were not taken into consideration in this investigation should explain the other part of the variation in the problem variable.

D. Summary

The foregoing analysis indicated several levels of association between explanatory and problem variables. There were relationships with coefficients as high as .50 and others with coefficients of .07 (see Table 8 in Chapter V). When the association was analyzed by categories of farmers, groups of explanatory variables and types of problem variables, these data showed that for farmers using the seedbed system and in relation to explanatory variables and the adoption score, 43 correlations were statistically significant. Thirty seven of those correlations were tested with $\alpha \leq .01$. Explanatory variables and degree of knowledge about new technology for the same farmers showed interrelation in 38 cases. In 37 opportunities, they were confirmed with $\alpha \leq .01$. Correlation for farmers using the direct seed system and in relation to explanatory variables and score of adoption were observed in 37 cases. Thirty one relationships were accepted at $\alpha \leq .01$. Explanatory variables and degree of knowledge about the innovations, in relation to the same farmers, had significant associations in 33 opportunities; 28 of them were tested with $\alpha \leq .01$ (see Table 8 in Chapter V).

Table 12 showed that all the factors (predictors) jointly accounted for 29.9 percent of the variation in score of adoption for farmers using the seedbed system. The most important predictors were Innovations' Characteristics, Change Agent's Characteristics, Seed and Labor Services, Farmer Interpersonal Communication, and Location of Marketing Services. These predictors explained 93.5 percent of the total explanation given by all the factors. When the analysis was made for the same farmers and factors, but in relation to degree of knowledge about the new technology, those same predictors occupied the first five positions explaining 98.1 percent of the 32.2 percent that was explained by all the factors in the equation (see Table 13). Innovations' Characteristics was the predictor with the largest explanatory capability in both equations (32.4 and 37.6 percent of the total explanation given by all the factors examined).

Change Agent's Characteristics was the second most important predictor in the adoption function, but it dropped to the fourth position in the knowledge function. Seed and Labor Services changed from third place in the adoption function to second position in the knowledge function. Farmer Interpersonal Communication also moved one step forward between score of adoption and degree of knowledge about innovations: it changed from step four in adoption function to step three in knowledge function. Location of Marketing Services kept the fifth position in both equations.

The other four factors used in the multiple regression model explained less than 7.0 percent in the adoption function and 2.0 percent in the knowledge function of the variance explained by both equations. These results showed that the four predictors appeared not to be very important in the innovation's diffusion process.

Since the total predictive power of both equations is rather low, it is apparent that some relevant elements affecting innovation's diffusion in producers with seedbed system are missing from the models. Other variables which could be related to the diffusion process, but which were not analyzed, are rainfall, temperature, soil structure and pH, land ownership, and farmer experience with rice before settling in the rice project.

Table 14 showed that all the predictors acting together accounted for 52.3 percent of the variation in score of adoption in relation to producers using the direct seed system. The same predictors for the same producers in relation to the degree of knowledge about released innovations accounted for 50.4 percent of the variation. In both functions, Inputs and Service Location occupied first position and Seed Service occupied second position. These two predictors explained more than 50.0 percent of the total explanation given by all the factors in this equation.

Change Agent's Characteristics occupied third place in the adoption function while it passed to fifth position in the knowledge function. Farmer Interpersonal Communication showed the same characteristic for producers using the seedbed system. It occupied fourth position in the adoption function and third place in the knowledge function for both kinds of farmers. Dogmatism of Farmers moved from fifth to fourth position when the equation changed from adoption to knowledge function. Farmers' Characteristics and Intensity of Cultivation kept sixth and seventh places, respectively in both equations. These first seven predictors accounted for 96.0 and 97.4 percent of the total variance related to adoption and knowledge functions explained by the two equations. Paradoxically, Innovations' Characteristics was not an important factor explaining innovation's diffusion, as only one related variable, observability of innovation, was in the equation and it occupied the last position in both cases.

The components of the multiple regression equations for producers using the direct seed system predicted better than the models for producers using seedbed system in the variance of the problem variables. In this case, the explanation was greater than 50.0 percent in both equations.

In the concluding chapter, these results are analyzed and the conclusions and recommendations are presented.

CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

At the outset it should be made clear that this research does not pretend to offer magical solutions to big, historical, and structural problems. It only seeks to help understand the variables affecting the innovation decision process in a manner that will facilitate the work of the people acting as decision-makers in the development and diffusion of rice technology in the country.

The dissertation had two goals: 1) to provide the knowledge necessary to explain the relationships between those factors most related to the diffusion and adoption of new rice technology in such a way as to improve the services of extension/education for the rice crop; and 2) as a policy-oriented research effort, to offer information needed to design and implement programs which could be useful to the rice farmers, to the rice industry, and to the Dominican Republic.

The foundations of the model that supports this research are: a) that in addition to the traditional factors used to explain innovation decision process, other relevant factors are the availability of the innovation itself, potential adopter need or desire, ability of the potential adopter to obtain the innovation and related inputs, and infrastructure facilities; b) that three steps are needed to improve the diffusion and adoption functions. First, the creation of diffusion infrastructure, which assumes the establishment of other public and private infrastructures that would facilitate the diffusion and adoption processes. second, the formulation and implementation of a strategy to induce adoption among the population in the service area. and third, the adoption decision process which has four stages (knowledge, persuasion, decision, and confirmation) and seven intervening factors (spatial factors, farmers' characteristics, change agent, services, and agro-climatological factors). It is important to keep in mind that there are biased innovations and neutral innovations. When the new technology needs more material inputs (water, fertilizers, pesticides, and machinery) or more labor than the old technology, it is defined as a biased innovation. On the other hand, when the new technology uses, more or less, the same amount of labor and material inputs, it is called a neutral innovation. If the innovation is biased toward the material inputs, the bigger and economically healthy producer will be in a better position to adopt it than the smaller and poorer farmer; whereas, if the innovation is labor-oriented, the small producer (who usually has a labor surplus because he has an extensive family) and the rural under-employed will benefit from the new technology. When the technology is a neutral innovation, both groups are able to adopt it at the same rate.

The last point is to emphasize a fact which is rather well known. That is, the diffusion of technological innovations generally has not reached a significant level in most of the developed countries, but instead, the tendency is to increase spatial inequalities and widen the disparities between social and economic classes as well as between regions in each country. If the distribution of the new technology is socially, economically, and locationally variant, then, the adoption process is facilitated more for some individuals or places than for others and as a result, will intensify the already existing disparities.

A. Conclusions

A general conclusion of this investigation is that the conceptual model underlying the research, the Marketing and Infrastructure Approach, was supported by the results from the equations. This finding is principally true with reference to the adoption function for both types of producers. Tables 12 and 14 show that none of the first three factors in both equations belong to communication diffusion channels or farmers' characteristics, describing the innovation decision process (e.g., elements emphasized in most other models such as Hypodermic Needle Model, One Step Flow Model, Multi-Step Flow Model, and Traditional Model). On the contrary, Innovations' Characteristics, Change Agent's Characteristics and especially for producers using the direct seed system, Location of Extension Agents, as well as, credit, fertilizers, pesticides, and seed services appeared to be the paramount elements in the adoption function; most of these last elements are emphasized, also, by the Marketing and Infrastructure Approach.

Since the actual model used by the Secretariat of Agriculture in the Dominican Republic to spread new technology is based principally on variables such as age, farm size, educational level, economic condition, social participation, degree of opinion leadership of the farmer, and the communication means used by the change agent (see CENDA, 1977:13-25; SEA, 1978a); this author believes that there are significant differences between the actual model used in the Republic and the results of this research. Hence, one additional conclusion obtained was that the extension and education model used in the Dominican Republic to spread new technology should be modified.

Another reason for this last conclusion is that most of the released technology in the country is materially or socially biased. The new technology needs more investments and inputs (such as water availability, management of floods, fertilizers, pesticides, machinery, and other scarce and expensive items) than the old one. In addition, those in inputs and services are not always available to the small farmers. With the new technology, the availability of credit and the inputs themselves are critical factors in the production function. In other words, the effective communication of the released innovations and the farmers' characteristics are not sufficient conditions in themselves to produce the adoption of the new technology. There are material or structural factors which have to be achieved before the adoption process is achieved (see Yapa, 1977: 355-356; Brown, 1975:198).

Intrinsic in this last idea is the concept that new technology, besides being problem-oriented (a technology developed according to the basic problems of the producers: scarcity of water, economic and material resource, low technological level and so on) must be market or client-oriented whenever the situation of the potential adopter is taken into consideration. For instance, the innovations may be designed to have a "technological package" based on farm size, access to resources and the farmer's current level of technology. An approach such as this one is used by the International Institute of Tropical Agriculture in Nigeria, where, before the development of the new technology, the Institute defines the general ecological system, agroecological system, and cultural-economic sub-systems of agricultural production (Saint and Coward, 1977:735).

One specific contradiction between new rice technology and the farmers' current patterns in the Dominican Republic is the following case: while many rice producers prefer to make a seeding and harvesting in the first season and wait for a second harvest from the same first seeding (it is by new sprout, which means less investment and effort), the new varieties need a seeding in each season in order to obtain two harvests per year. If the new variety is more compatible with the current technological situation, perhaps the adoption function could be faster and more effective.

Another conclusion, based on the findings of this research, is that mass media channels appear to be more important for the knowledge function, while the interpersonal channels are more important in the adoption function. This outcome means that in the first phase of the diffusion process, the mass media can be used to create expectation and awareness, but before the adoption process reaches a large number of rice growers, personal contact between change agent and producers is needed.

The last conclusion is that, although the current policy and goals of the public institutions working with rice in the country can be maintained, the strategy used to deal with these policies and goals should be adapted according to the new understanding of the technological phenomenon. For instance, the economic, human, and institutional resources should be rearranged to consider elements (innovations' characteristics, change agent, location, credit, and availability of material inputs such as water, improved seed, fertilizers and pesticides) which are not completely being considered.

B. Recommendations

Because all technology is a social product (which means that all technology depends upon the manner in which the social system is organized, the general level of development, and the development in the scientific and technological sector), biased-innovations come from biased-social conditions. Hence, it can be hypothesized that before necessary and sufficient corrective measurements can be made, a significant change, at least, in the structural conditions of the agricultural sector has to be accomplished.

Since the Dominican Republic is attempting to achieve the goal of self-sufficiency in rice production, requiring an increase in the expected production in 1979 by 11.3 percent (548,285 quintals), (SEA, 1978a:3), and since this objective may be principally reached by increasing yield because productivity had been more dynamic than area increasing in the past years (see Table 1, Chapter One), this study recommends that the strategy to carry out the current policy should require a broader approach. In designing such a broader approach, the following points should be considered:

1. Redefinition of the system and role of the Juma Experimental Station which leads in the development and diffusion of rice technology in the country. This recommendation has four parts:

   a) Keep the current objectives about the rice industry which are: growth of production as quickly as possible to satisfy the domestic demand, increase construction of infrastructures and improve management in rice areas, and to train rice producers in such a way that new rice technology effectively reaches the farmers (SEA, 1978c:1 and 2).

b) Since rice is the most important staple food in the country, and the staff working at the Juma Experimental Station has been doing a laudable job for more than sixteen years, despite the lack of resources and several changes in public policies and strategies, this author believes that the country may take advantage of the experiences and facilities at the Juma Experimental Station so that this situation can be transformed into a Dominican Rice Institute.

   In such a way, Juma will be able to examine all the topics related to rice production. For instance, in addition to rice research and training, such an institute could take charge of extension activities, statistical collection and analysis, and programming and monitoring of rice development programs. Following this change, economic, human, and institutional resources could be assigned according to the new activities and responsibilities.

c) Because rice producers are affected by the actions of the persons leading the Juma Experimental

Station, the diffusion and adoption of the new technology also can have negative results: further concentration of agricultural income (Beltran, 1971), adverse effects on rural employment (Barket, 1972: 111-129), and expulsion of some small plot owners from their land (Stavenhagen, 1968), this study recommends that the private sector (rice producers, buyers and dealers, dryers and warehouse managers) may be incorporated into the institutional system leading the development and diffusion of rice technology. The private sector may participate in defining, supporting and monitoring activities related to their industry. Before the definition of what, how, when and where to do with rice, all persons involved in these activities may be consulted. Those interested parties can be integrated into the decision-making process through the creation of a board of directors to lead the Dominican Rice Institute. Interested parties to the rice industry may have their representative on such a board.

d) Since the findings of this research demonstrated that there are relevant factors in the innovation diffusion process which are not being taken into consideration in the country to spread the new technology, this study suggests that the current innovations diffusion model should be redesigned to incorporate, in addition to traditional factors such as the communication channels and farmers' characteristics, elements about innovations' characteristics, change agent's characteristics, and inputs and services like water supply and flood control, seed, fertilizers, pesticides, labor, machinery, and credit. The author recommends that such a modified model, however, should be tested on a limited scale (for example, a rice area in each of the four rice regions) before it is placed into operation.

2. That the government guarantees the availability of the inputs (credit, water, fertilizers, pesticides, labor, machinery storage and other services) in sufficient amount, quality and prices in order to prevent the bottlenecks that affect present rice production. This guarantee can be in one of two forms: a) through pricing mechanisms, by establishing policies about gain levels for the dealers of inputs; and b) by increasing government subsidies such as public inputs, shops which can absorb part of the marketing costs to keep the consumer's price under the regulated market.

3. That the government carry out studies to determine benefit/cost relationship. Based on such studies, the Secretariat of Agriculture can establish levels of gains for the different sectors involved in this industry which

in time would stimulate the achievement of self-sufficiency through increasing yield and production.

Despite these conclusions and recommendations, this writer would be the first to admit there are no simple answers to the problem of agricultural development as a whole and to rice production in particular. If any country wants to reach self-sufficiency, it must have programs which combine careful planning and sustained, energetic, and effective implementation. Only sustained support of research and extension/education programs and the expansion of irrigation systems and inputs services can form the conditions of a successful rice production program.

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APPENDIX

APPENDIX

ENCUESTA SOBRE LA DETERMINACION DE LOS FACTORES ASOCIADOS CON LA DIFUSION DE INNOVACIONES EN EL CULTIVO DEL ARROZ EN LA REPUBLICA DOMINICANA

INFORMACION GENERAL

1. Número del parcelero ____ (1, 4)
2. Número de la tarjeta A (5)
3. Nombre del parcelero ____ (6-34)
4. Area de la parcela (Ta.) ____ (35-37)
5. Producción de la parcela (qqs. de 100 lbs) ____ (38-40)
6. Productividad (qqs. en arroz blanco) ____ (41-43)
7. Costo de producción por tarea: RD$____ ____ (44-48)
8. Nombre y No. del Proyecto____________ ____ (49-53)
9. Tipo de Proyecto: Individual (1)
   Colectivo (2) ____ (54)
10. Tipo de colectivización: ____________ ____ (55)
11. Nombre de la finca en Proyecto Colectivo: ____________ ____ (56-57)
12. Localización: Paraje: ____________ ____ (58-60)
    Sección: ____________ ____ (61-63)
    Municipio: ____________ ____ (64-66)
    Provincia: ____________ ____ (67-69)

Observaciones: a) Sobre el Proyecto: ____________

____

____

b) Sobre la realización de la encuesta:

____

____

____

Nombre del encuestador: ____________

Fecha de realización: ____________

CUESTIONARIO SOBRE EL NIVEL DE ADOPCION Y CONOCIMIENTO DE LAS RECOMENDACIONES FORMULADAS POR LA ESTACION EXPERIMENTAL ARROCERA DE JUMA-BONAO

Si el agricultor está usando o conoce lo recomendado por la Estación, asignar un valor de uno (1); si el agricultor no esta usando o no conoce la recomendación, asignar un valor de cero (0). Lo recomendado por la estación está entre paréntesis. La fecha será requerida solamenta para algunas innovaciones y ésta será anotada como: Primera (1) o segunda (2) siembra y el año (últimos dos numeros) en que se adoptó la innovación.

Número del Parcelero: ____ (1-4)
Número de Tarjeta: B (5)

Recomendación Hecha por la Estación	USA O CONOCE	FECHA
Variedades		
1. Cuales variedades usted usó durante la pasada cosecha? (Juma-1, IR-5, IR-6, CICA-4, Juma-32, Juma 57, Juma-58, Tanioka (Juma-60)	____(6) ____(10)	____(7-9)
Preparación del terreno		
2. Cuales labores usted usa o conoce en la preparación de terreno? (Corte, cruce y rastra).	____(11) ____(15)	____(12-14)
3. Cual es la profundidad con que usted corta el suelo al preparar el terreno? (De 18 a 22 centimetros)	____(16) ____(17)	
4. Hace usted curvas de nivelación? (Si)	____(18) ____(19)	
5. Deben ser hechas las curvas de nivelación en seco o "fangueo"? (En seco)	____(20) ____(21)	
6. Hace usted las labores de muréo con palas o con equipos que siguen las curvas de nivelación o forman cuadros? (Con equipos)	____(22) ____(26)	____(23-25)

USA O CONOCE FECHA

7. En que momento de la preparación del terreno usted hace las labores en "fanguéo"?
(Durante la nivelación) ____(27)
____(28)

8. Cuando usted aplica el fanguéo al terreno? (De 2 a 3 semanas despues del corte, cruce y rastra) ____(29)
____(30)

9. Usa usted arado de discos, vertederas o rastra para la preparación del terreno?
(Arado de vertedera) ____(31) ____(32-34)
____(35)

10. Cuales equipos usa usted para hacer la nivelación?
(Con equipos de tractor, no con palo o equipo manual) ____(36) ____(37-39)
____(40)

Siembra

Hace usted semillero y trasplante o siembra directa?

(Si siembra directo, pasar a pregunta 11)
(Si semillero y trasplante, pasar a pregunta 19)

11. Que cantidad de semilla usted utiliza en la siembra directa?

(14 a 16 libras/tarea) ____(41) ____(42-44)
____(45)

12. En que forma hace usted la siembra?
(Al "voléo" o con avión) ____(46)
____(47)

13. En cuales fechas hace usted las siembras? Si hace una sola siembra

(Desde Diciembre 15 hasta Julio) ____(48)
____(49)

Si hace dos siembras:
- Primera siembra:
(Diciembre 15 a Febrero 30) ____(50) ____(51-53)
- Segunda siembra:
(Junio a Julio 15) ____(54)
____(55) ____(56-58)
____(59)

USA O CONOCE   FECHA

14. Como tiene usted el terreno y en que forma planta la semilla en siembra directa?

(Terreno húmedo y semilla pre-germinada o terreno con 1-2 pulgadas de agua y semilla no pre-germinada) ____(60)
____(61)

15. Cuantos dias despues de la siembra le da usted el primer "baño" al campo?

(De 8 o 10 dias) ____(62)
____(63)

16. Que cantidad de agua usted le suministra al campo?

-Después del primer baño y hasta el final del segundo mes:

(Menos de una pulgada) ____(64)
____(65)

-Despues de la planta adulta:

(La lámina debe ser menor de 4 o 5 pulgadas o 10 a 12 centimetros) ____(66)
____(67)

17. Cuantas aplicaciones de fertilización hace usted al cultivo?

(Tres) ____(68) ____(69-71)
____(72)

18. En cuales fechas efectua usted la aplicación de fertilizantes?

-Primera aplicación:

(50 a 60 dias despues de la siembra)____(73)
____(74)

-Segunda aplicación:

(50 a 60 dias después de siembra) ____(75)
____(76)

-Tercera aplicación:

(20 a 25 dias antes del "desembuche")____(77)
____(78)

Solamente para los que Hacen Semillero

19. Que forma y tamaño le da usted al terreno para el semillero?

(Surcos o canteros de 1.5 a 2.3 metros de ancho) ____(79)
____(80)

	USA O CONOCE	FECHA
Número del Parcelero:	____(1-4)	
Número de tarjeta:	C (5)	

20. En que fecha hace usted el semillero para la primera siembra?

(Del 15 de Diciembre al 28 de Febrero) ____(6) ____(7-9)
____(10)

21. Que cantidad de semilla por tarea usted siembra en el semillero?

(Si cantero: de 1.5 a 2 qqs./ta.) ____(11)
____(12)

Si cuadros bien nivelados: 2 a 3 qqs./ta.) ____(13)
____(14)

22. Siembra usted las semillas generalmente húmedas o secas?

(Sembradas secas) ____(15)
____(16)

23. Cuantos dias despues de la siembra del semillero hace usted el primer riego?

(El segundo dia de la siembra) ____(17)
____(18)

24. Que preparación del área usted dedica al semillero, en relación al area a sembrar?

(De 2 a 5%, de 1 a 20 o 25) ____(19)
____(20)

25. Que cantidad de fertilizantes de formula completa usted us por tarea para el semillero?

(Fórmula: 15-15-15 igual 10-46 libras/Ta.) ____(21) ____(22-24)
(Fórmula: 12-24-12 igual 12-58 libras/Ta.) ____(25)

USA O CONOCE FECHA

26. En que fecha usted aplica la fertilización?

(De 7 a 10 dias después de la siembra) ____(26)
____(27)

27. En que forma usted aplica el fertilizante?

(Al voléo y en una sola aplicación) ____(28)
____(29)

28. Que cantidad de pesticida por tarea usted usa durante el semillero?

(Furadan: 2 a 1.4 libras/Ta.
Bim: 5 Tareas por galón
Hinosan: 5 tareas por galón
Kasumin: 5 tareas por galón
Endrin: 6 tareas por galón) ____(30)
____(31)

29. Que tiempo después de la germinacion usted aplica el pesticida?

(Una semana después de la germinacion, y luego, cuando se presenta el ataque) ____(32)
____(33)

30. En que forma aplica usted el insecticida?

(Con bomba manual o de mochila, con avión) ____(34)
____(35)

31. Que tiempo antes de hacer el trasplante usted prepara el terreno?

(Antes o conjuntamente con el semillero) ____(36)
____(37)

32. A los cuantos dias después de hacer el semillero usted trasplanta para la primera siembra?

(De 35 a 45 dias) ____(38) ____(39-41)
____(42)

		USA O CONOCE	FECHA
33.	Siembra usted la planta de arroz en forma recta o inclinada (forma recta)	____(43) ____(47)	____(44-46)
34.	Cuantos golpes o matas hace usted por metro cuadrado? (A una carta; 25 por 25 ctms.; de 16 a 20 golpes)	____(48) ____(52)	____(49-51)
35.	Cuantas plantas por golpe siembra usted? (De 4 a 5 plantas)	____(53) ____(54)	
36.	A que profundidad siembra usted las plantas? (De 1 a 2 pulgadas)	____(55) ____(56)	
37.	Que tiempo máximo pueden estar las plantas fuera del semillero sin ser trasplantadas? (Dos dias)	____(57) ____(58)	
38.	Durante cuantos dias usted suministra el agua al campo después del trasplante? (Mínimo 3 dias)	____(59) ____(60)	
39.	Que cantidad de agua usted la suministra al campo después del trasplante? (De 3 a 5 centímetros o 1.5 a 2 pulgadas)	____(61) ____(65)	____(62-64)
40.	Cuantos abonamientos hace usted despues del trasplante? (Tres)	____(66) ____(70)	____(67-69)

USA O CONOCE FECHA

41. En cuales momentos hace usted los abonamientos?

-Primer abonamiento:
(De 7 a 10 dias despues del trasplante)
____(71)
____(72)

-Segundo abonamiento:
(De 20 a 25 dias antes del "desembuche")
____(75)
____(76)

Preguntas para Todos los Parceleros

42. Cuantos dias antes de aplicar fertilizantes, hierbicidas, insecticidas, etc. usted retira el agua del campo?

(De 1 a 3 dias)
____(77)
____(78)

43. Cuantos dias después de aplicar fertilizantes, hierbicidas, insecticidas, etc. usted repone el agua del campo?

(De 1 a 2 dias)
____(79)
____(80)

Número del Parcelero: ____(1-4)
Número de la tarjeta: D (5)

44. Cual es la cantidad de abono aplicado durante la primera siembra?

-Primera aplicación:
(15-15-15: 35 a 40 lbs./Ta.
12-24-12: 45 a 50 lbs./Ta.
13-13-13: 42 a 45 lbs.Ta.
16-20-0: 35 a 40 lbs./Ta.)
____(6) ____(7-9)
____(10)

-Segunda Aplicación:
(15-15-15: 35 a 40 lbs./Ta.
12-24-12: 45 a 50 lbs/Ta.
13-13-13: 42 a 45 lbs./Ta.
16-20-0: 35 a 40 lbs./Ta.)
____(11) ____(12-14)

USA O CONOCE   FECHA

-Tercera Aplicación:
(UREA: de cero (0) a 6 libras/Ta.
Sulfato de amonio: de cero (0) a
14 lbs./Ta.)   ____(16) ____(17-19)
____(20)

45. En qué forma hace usted el abomiento?

(Manual, al "voléo", o por avión)   ____(21)
____(22)

46. A cuantas tareas le aplica usted un galón de hierbicida pre-emergente?

(Machete: un galon igual 24 tareas
Bolero: un galon igual 8.62 Tas.
Tordan: un galon igual 42-31 tareas
Stan: un galon igual 4 tareas   ____(23) ____(24-26)
____(27)

Para los que Hacen Trasplante

47. Cuantos dias despues del trasplante usted aplica el hierbicida señalado en la pregunta anterior?

(De 4 a 7 dias)   ____(28)
____(29)

Para Todos los Parceleros

48. A cuantas tareas le aplica usted un galón de 2, 4-D; Stam f-34; Tordan?

(Del 2,4-D: Igual 42-31 tareas por galón;
Del Stam f-34: igual 4 tareas por galón;
Del Tordan: igual 42-31 tareas por galón)   ____(30) ____(31-33)
____(34)

49. En que momento usted aplica el hierbicida señalado en la pregunta anterior?

(Cuando la maleza tiene de 1 a 3 hojas)
____(35)
____(36)

USA O CONOCE FECHA

50. Cuantas tareas usted trata con un galón de fungicida para controlar la pyricularia?

(Benlate: 12-9 tareas por libra
Kasumin: 51 tareas por galón
Bla-S: 51 tareas por galón
Hinosan: 51 tareas por galón
Kitazin: 51 tareas por galón)

____(37)
____(38)

51. Qué cantidad de pesticida usted aplica para controlar un "ataque"?

(Endrin: 59 tareas por galón
Asodrin: 100 tareas por galón
Sevin: 100 tareas por galón
Furada: 18-12 tareas por quintal)

____(39) ____(40-42)
____(43)

52. En qué momento usted aplica pesticida para controlar un "ataque"?

(Cuando se presenta el "ataque")

____(44)
____(45)

53. Cuantos dias antes de cosechar usted seca la parcela?

(Suelo no-arcilloso: de 5 a 7 dias
Suelo arcilloso: 10 a 15 dias)

____(46)
____(47)

54. Con que proporción de madurez en la espiga usted inicia la cosecha?

(De 70 a 80% de madurez)

____(48)
____(49)

CUESTIONARIO SOBRE LAS VARIABLES EXPLICATIVAS DEL NIVEL DE CONOCIMIENTO Y GRADO DE ADOPCION DE LAS RECOMENDACIONES ("TECHNOLOGICAL PACKAGE") FORMULADAS POR LA ESTACION EXPERIMENTAL ARROCERA DE JUMA-BONAO

Cada variable sera medida en base a una escala de cinco (5) alternativas (del uno(1) al cinco (5). El nivel uno (1) representa la condicion mas positiva para el conocimiento y adopción de las innovaciones. El nivel cinco (5) representa la conditión mas negativa para el conocimiento y adopción de las innovaciones. Del dos (2) al cuatro (4) son conditiones intermedias. Si el entrevistado no sabe o no recuerda poner numero 3.

Número del Parcelero: ____ (1-4)
Número de la tarjeta: ____ (5)

1. Condición o Característica

1.1 Cree usted que las ventajas económicas (rendimiento, relación costo-beneficio, etc.) de las nuevas variedades y recomendaciones que hace la Estación son: (6) ____

Muy mejores que las tradicionales
Mejores que las tradicionales
Neutral
Peores que las tradicionales
Muy peores que las tradicionales

1.2 Cómo compara usted las nuevas variedades y prácticas que recomienda la Estación con las variedades y prácticas que tradicionalmente son usadas por los arroceros? (7) ____

Muy parecidas
Parecidas
Iguales
Diferentes
Bien diferentes

1.3 En cuanto a la complejidad de las nuevas variedades y practicas, cree usted que ellas son: (8) ____

Bien fáciles de entender
Se pueden entender
Neutral
No es fácil de entender
No se pueden entender

1.4 Cual es el nivel de aplicabilidad que usted considera tienen las recomendaciones (Forma y momento de preparacion del terreno; calidad y modo de aplicar agro-quimicos, etc.) ofrecidas por la Estacion? (9) ____

Muy aplicables
Ligeramente aplicables
Neutral
No muy aplicables
No aplicables

1.5 Como considera usted los resultados entre las nuevas variedades y practicas recomendadas por la Estacion y las variedades y practicas tradicionales: (10) ____

Los resultados son amplios y observables
Los resultados son medianamente superiores y observables
Neutral
Bastante inferiores y no observables
Completamente diferentes y no observables

2. Factores Espaciales

2.1 Cree usted que la localizacion del tecnico agricola que trabaja en el proyecto esta: (11) ____

Muy cerca del proyecto
Cerca del proyecto
Neutral
Lejos del proyecto
Muy lejos del proyecto

2.2 Que tan distante considera usted que fueron montadas las parcelas y campos demostrativos realizadas en esta zona? (12) ____

Muy cerca
Cerca
Neutral
Lejos
Muy lejos

2.3 Que tan distante del proyecto considera usted la oficina de crédito agrícola que atienda este proyecto? (13) ____

Muy cerca
Cerca
Neutral
Lejos
Muy lejos

2.4 Que tan distante del proyecto considera usted que estan localizados los vendedores y las casas agroquímicas? (14) ____

Muy cerca
Cerca
Neutral
Lejos
Muy lejos

2.5 Que tan distante del proyecto considera usted que estan localizadas las facilidades de almacenamiento? (15) ____

Muy cerca
Cerca
Neutral
Lejos
Muy lejos

2.6 Que tan distante del proyecto considera usted que estan localizados los compradores de arroz? (16) ____

Muy cerca
Cerca
Neutral
Lejos
Muy lejos

3. Características del Agricultor

a) Características Socio-Económicas:

3.a.1 Cuál es su edad actual? (17) ____

Menos de 30 años
de 31 a 40 años
de 41 a 50 años
de 51 a 60 años
Mas de 60 años

3.a.2 Cuantas personas viven in su casa que dependen económicamente de usted? (18) ____

Menos de 2 personas
de 3 a 4 personas
de 5 a 6 personas
de 7 a 8 personas
Mas de 9 personas

3.a.3 Cuál de estas categorías representa mejor el tamano de su parcela? (19) ____

Mas de 80 tareas
de 70 a 79 tareas
de 60 a 69 tareas
de 50 a 59 tareas
Menos de 50 tareas

3.a.4 En cuál de estos niveles de escolaridad se ubicaria usted? (20) ____

Mas de 8vo. grado
de 7mo. a 8vo. grado
de 5to.a 6to. grado
de 3ro. a 2do. grado
menos de 2do. grado

3.a.5 En cuál de estos grupos de status social usted se clasificaría? (21) ____

-Entre los que tienen mas posibilidades en el proyecto,
-Con posibilidades regulares,
-Como la mayoría del proyecto,
-Con menos posibilidades que el promedio del proyecto,
-Con las menores posibilidades dentro del proyecto

3.a.6 Considera usted que su parcela es: (22) ____

Completamente comercial
Medianamente commercial
Ni comercial ni subsistente
Medianamente subsistente
Completamente subsistente

3.a.7 El dinero que usted utiliza para la cosecha es? (23) ____

Solamente suyo
suyo y del Banco
del Banco solamente
del Banco y algun intermediario
de intermediarios solamente

3.a.8 En cual de estas categorias esta major ubicada su parcela? (24) ____

Siembra solamente una variedad de arroz
Siembra más de una variedad de arroz
Siembra más de una variedad de arroz
Siembra arroz y otros cultivos

b) Características Personales

3.b.1 En que grado le gusta a usted participar en grupos, reuniones y actividades de la comunidad? (25) ____

Mucho
Regular
Mas o menos
Poco
Muy poco

3.b.2 En que grado considera usted que las tradiciones, valores y prácticas de las comunidades, grupos y personas deben cambiar? (26) ____

Muchísimo
Mucho
Poco
Casi nada
Nada

3.b.3 Elabora usted algun plan y presupesto donde analiza, desde el punto de vista económico, todas las actividades y formas de las actividades antes de realizar dichas actividades? (27) ____

Siempre
Generalmente
A veces
Raras veces
Nunca

3.b.4 Considera usted que el probar con nuevas variedades y practicas de cultivos es: (28) ____

Muy deseable
Deseable
Ni deseable ni no deseable
Mas no deseable que deseable
Nada deseable

3.b.5 Considera usted que ensayar algo de lo cual uno no está muy seguro, aunque el resultado podría ser muy positivo, es una actividad: (29) ____

Nada riesgosa
Medianamente riesgosa
Neutro
Riesgosa
Muy riesgosa

3.b.6 Considera usted que el hecho de que un parcelero tenga que trabajar con crédito es una situación: (30) ____

Deseable
Medianamente deseable
No deseable no indeseable
Medianamente indeseable
Completamente indeseable

3.b.7 Considera usted que los descubrimientos y avances de la ciencia y la tecnología es algo que representa para las personas: (31) ____

Mucha utilidad
Utilidad
Neutral
Poco utilidad
Nada de utilidad

3.b.8 Como valora usted las posibilidades de que sus hijos posean buena educacion académica, buen trabajo, y buenas condiciones de vida? (32) ____

Muy importante
Importante
Neutral
Poco importante
Nada importante

c) Comportamiento del Agricultor en Relación a los Medios de Comunicación

3.c.1 Considera usted que hacer reuniones, conversar e intercambiar ideas con los demas miembros del proyecto, con otras personas de la comunidad en que usted vive, y con personas que viven en otras comunidades y regiones es algo: (33) ____

Importante
Medianamente importante
Neutral
No muy importante
Nada importante

3.c.2 Su sentido de identificación y solidaridad (companerismo) con el proyecto y su comunidad se podría definir como: (34) ____

Mucho
Mediana
Neutral
Poca
Nada

3.c.3 Considera usted que la forma en que viven las personas en Santo Domingo y las ciudades grandes es algo: (35) ____

Deseable
Medianamente deseable
Indiferente
Poco deseable
No deseable

3.c.4 Considera usted que el número de veces que lo visita el técnico agricola durante la cosecha son: (36) ____

Suficiente
Medianamente suficiente
Neutral
Medianamente insuficiente
Insuficiente

3.c.5 Considera usted que sus contactos con la radio, television, periodicos, revistas, etc. son: (37) ____

Frecuentes
Medianamente frecuentes
Medio
Poco frecuentes
Nada frecuentes

3.c.6 Considera usted que su asistencia a reuniones, conferencias, charlas, cursos, cursillos, dias de campo, demostraciones, peliculas educativas, etc. es: (38) ____

Frecuente
Medianamente frecuente
Medio
Poco frecuente
Nada frecuente

3.c.7 Considera usted que las personas y amigos que lo consultan a usted para tratarle asuntos personales o del trabajo son: (39) ____

Muchos
Bastantes
Neutral
Pocos
Ninguno

4. Caracteristicas del Tecnico Agricola

4.0 Recibo usted alguna visita del Tecnico Agricola (del IAD o la Secretaria de Agricultura) durante este ano?

-En caso positivo seguir con pregunta 4.1
-En caso negativo pasar a pagina 27, pregunta 5.1

4.1 Cree usted que el esfuerzo que hace el tecnico Agricola para ayudar al parcelero es: (40) ____

Suficiente
Medianamente suficiente
Neutral
No suficiente
Nada

4.2 Considera usted que los conocimientos
que tiene el técnico agrícola del
cultivo del arroz son: (41) ____

Muy buenos
Buenos
Neutral
No suficientes
Ninguno

4.3 Cree usted que la inclinación del técnico agrícola, en relación a si lo defiende mas a usted o la Institucion para
quien trabaja es: (42) ____

-Completamente identificado con el parcelero
-Parcialmente identificado con el parcelero
-No inclinado ni para uno ni para otro
-Parcialmente inclinado con la Institucion
de trabajo
-Completamente identificado con la Institucion de trabajo

4.4 Considera usted que las actitudes, creencias
y conductas del técnico agrícola son: (43) ____

Muy parecidas a las suyas
Parcialmente parecidas
Neutral
Diferentes
Muy diferentes

4.5 Cree usted que la forma de ser del técnico
agrícola es: (44) ____

Muy parecida a la suya
Parcialmente parecida a la suya
Neutral a la suya
Diferente a la suya
Muy diferente a la suya

4.6 Considera usted que las condiciones sociales y económicas del técnico agrícola
que atiende este proyecto son: (45) ____

Muy buenas
Parcialmente buenas
Neutral
Parcialmente malas
Muy malas

4.7 Cree usted que la participacion en la comunidad del técnico agrícola que atiende este proyecto es: (46) ____

Muy activa
Parcialmente activa
Neutral
Poco activa
Nada activa

4.8 Considera usted que el técnico agrícola que atiende este proyecto es una persona con: (47) ____

Mucha influencia en la comunidad
Mediana influencia en la comunidad
Neutral
Poca influencia en la comunidad
Nada de influencia en la comunidad

4.9 Cree usted que la credibilidad del técnico agrícola entre los componentes de este proyecto es: (48) ____

Alta
Mediana
Neutral
No mucha
Nada

5. Servicios

5.1 Considera usted que el monto, la oportunidad y las condiciones de los créditos que ofrece el Banco Agricola son: (49) ____

Satisfactorias
Medianamente satisfactorias
Neutral
No muy satisfactorias
Nada satisfactorias

5.2 Cree usted que la cantidad, calidad y oportunidad para obtener la semilla de las nuevas variedades de arroz son: (50) ____

Satisfactorias
Medianamente satisfactorias
Neutral
No muy satisfactorias
Nada satisfactorias

5.3 Considera usted que la cantida disponible calidad oportunidad y condiciones en que es consiguen los fertilizantes, pesticidas, hierbicidas, raticidas, maquinarias agricolas y facilidades de riego y drenaje son: (51) ____

Satisfactorias
Medianamente satisfactorias
Neutral
No muy satisfactorias
Nada satisfactorias

5.4 Cree usted que la disponibilidad de mano de obra y las condiciones bajo las cuales ella trabaja son: (52) ____

Satisfactorias
Medianamente satisfactorias
Neutral
No muy satisfactorias
Nada satisfactorias

5.5 Considera usted que las facilidades existentes de recolectar la cosecha, transportacion, secado y almacenamiento, y las condiciones bajo las cuales se obtienen estas facilidades son: (53) ____

Satisfactorias
Medianamente satisfactorias
Neutral
No muy satisfactorias
Nada satisfactorias

5.6 Cree usted que la relacion entre lo que usted invierte y lo que usted obtiene para la cosecha del arroz el algo: (54) ____

Satisfactorio
Medianamente satisfactorio
Neutral
No muy satisfactorio
Nada satisfactorio

6. Medios de Comunicacion

6.1 Oye, ve, recibe y lee usted programas agricolas radiales, peliculas, revistas y publicaciones agropecuarias con tal frecuencia que usted puede considerar que es: (55) ____

Muy frecuente
Bastante frecuente
Neutral
Poco frecuente
Nada frecuente

6.2 Considera usted que las veces que usted se reúne con otros parceleros en forma individual o grupal, o con otras personas o grupos para tratar temas agropecuarias es: (56) ____

Muy frecuente
Bastante frecuente
Neutral
Poco frecuente
Nada frecuente

BIOGRAPHICAL SKETCH

Agapito Pérez Luna was born in San Cristobal, Dominican Republic, on August 19, 1943. His family moved to Santo Domingo in 1951 and since then he has lived there except for a few years spent in academic activities. He graduated in 1965 from high school at the Eugenio María de Hostos School, Santo Domingo. University studies in sociology began at the Autonomous University of Santo Domingo in August, 1966. Two years later, he transferred to the University of Puerto Rico, Rio Piedras Campus, San Juan, where he received his B.A. in Sociology in June, 1970. After that, he went back to Santo Domingo for six months, but he returned to the University of Puerto Rico again in January, 1971, where he registered at the Planning Graduate School. He received his M.S. degree in December, 1972; social planning and agricultural planning were his major and minor fields, respectively.

This author began to work as agricultural planner at the Planning Office in the Secretary of State of Agriculture, Santo Domingo, in July, 1973. After one year in this function, he was promoted to Assistant Director of the Planning Office. Some months later, he was promoted to Director of the Extension and Education Department in the same Secretariat. He was also a professor of General Sociology for two semesters in the East Central University at San Pedro de

Macorís.

He resigned his appointment at the Department of Extension Education under an agreement to initiate studies at the Ph.D. level in September, 1975. After studying English at the English Language Institute (ELI), at the University of Florida (UF), Gainesville, he initiated the Ph.D. studies at the Geography Department in the UF in March, 1976, with a major in socio-economic analysis and minor in rural agricultural development.

His areas of interest include: rural sociology, agricultural development and rural planning, as well as agricultural geography. The writer expects, after finishing his studies in geography, to go back to the Dominican Republic and work again as a planner and at the same time undertake further research.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Professor of Geography and
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Virginia R. Hetrick
Assistant Professor of Geography

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Carl W Spurlock

Carl W. Spurlock
Associate Professor of Geography

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Peter J. VanBlokland
Assistant Professor of Food and
Resource Economics

This dissertation was submitted to the Graduate Faculty of the Department of Geography in the College of Liberal Arts and Sciences and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August, 1979

Harry H. Sisler
Dean, Graduate School